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NATIONAL DAM SAFETY PROGRAM. MINE LAKE DAM (INVENTORY NUMBER NY--FTC(U)
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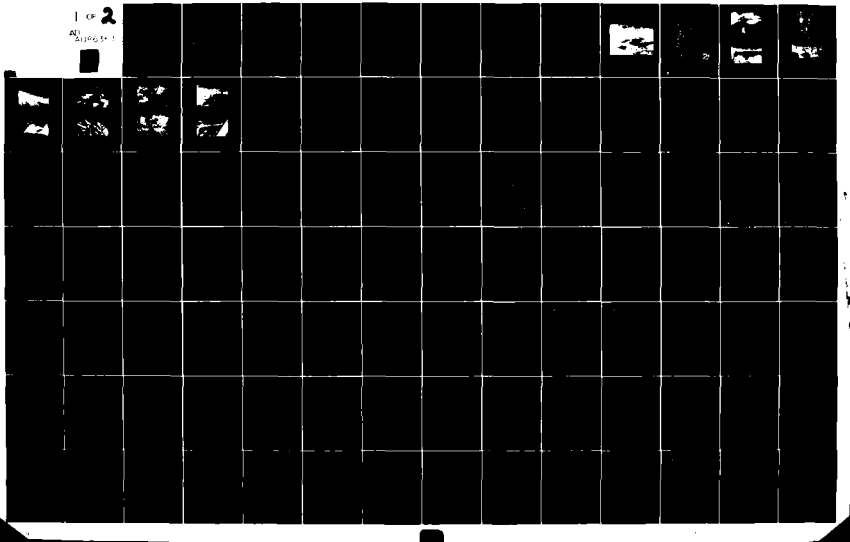

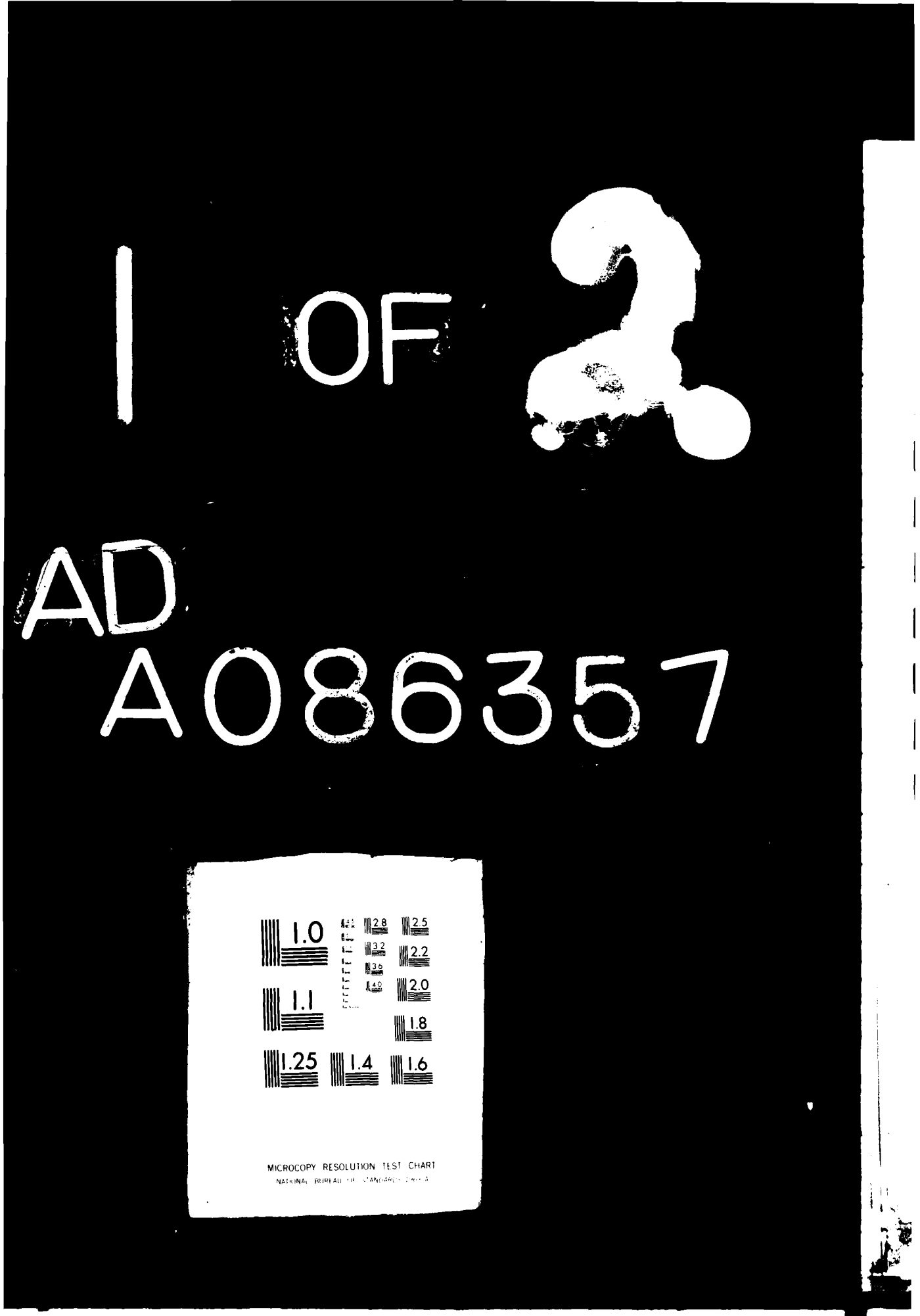
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LOWER HUDSON RIVER BASIN,

MINE LAKE DAM

(Inventory Number NY 767)

ORANGE COUNTY,
NEW YORK.

INVENTORY NO. NY 767

LEVEL II

PHASE I INSPECTION REPORT,
NATIONAL DAM SAFETY PROGRAM

(11) 14 Feb 80 (12) 91

NEW YORK DISTRICT CORPS OF ENGINEERS

JULY 1979

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

Mine Lake Dam is classified as a small dam with a significant hazard potential. The dam is constructed of masonry and is 13.9 feet high and 515 feet in length. Over 300 feet of the dam's length is less than 8 feet in height. The dam's reservoir is only 25 acres. Popolopen Dam is located one mile above Mine Lake, while Stilwell Dam and reservoir is located a few hundred feet below Mine Lake Dam. The drainage area of the dam is 8.7 square miles. The structure forms an impoundment which is used for recreational purposes on the West Point Military Reservation.

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Hydrology computations prepared according to the Corps of Engineers' screening criteria establishes the spillway capacity of 1,492 cfs at 9.9 percent of the PMF with the PMF discharge at 15,070 cfs and the 1/2 PMF discharge at 7,170 cfs. Since the spillway cannot pass the 1/2 PMF discharge without overtopping the dam, the spillway is inadequate.

The stability analysis determined three loading cases where the dam was unstable. Each of these cases involved uplift on the base of the dam due to hydrostatic forces in combination with the PMF, seismic loadings or ice loadings. Only the ice load occurs in a normal operating situation. The condition of uplift is plausible since seepage was observed at the juncture of the masonry spillway with the bedrock.

It is recommended the following remedial measures be completed within two years:

1. The seepage condition and leakage of the dam should be eliminated by sealing deteriorated mortar joints and open joints.

2. Steps should be taken to ensure the dam acts as a monolith. Additional material should be added to the section to increase stability. Since seismic forces are a possibility, the dam section should be able to retain stability under realistic loading conditions which include hydrostatic uplift.

3. The low level outlet should be moved from its present position below the center of the spillway or provided with some means of remote control of the valve controlling the outlet.

4. The dam should continue to be drawndown in the winter to reduce ice pressure effects on the dam until such time as the dam is repaired.

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam Mine Lake Dam NY767

State Located New York
County Located Orange
Stream Popolopen
Date of Inspection May 16, 1979, and June 21, 1979

ASSESSMENT OF GENERAL CONDITIONS

Mine Lake Dam is classified as a small dam with a significant hazard potential. The dam is constructed of masonry and is 13.9 feet high and 516 feet in length. Over 300 feet of the dam's length is less than 8 feet in height. The dam's reservoir is only 25 acres. Popolopen Dam is located one mile above Mine Lake, while Stilwell Dam and reservoir is located a few hundred feet below Mine Lake Dam. The drainage area of the dam is 8.7 square miles. The structure forms an impoundment which is used for recreational purposes on the West Point Military Reservation.

Hydrology computations prepared according to the Corps of Engineers' screening criteria establishes the spillway capacity of 1,492 cfs at 9.9 percent of the PMF with the PMF discharge at 15,070 cfs and the 1/2 PMF discharge at 7,170 cfs. Since the spillway cannot pass the 1/2 PMF discharge without overtopping the dam, the spillway is inadequate.

The stability analysis determined three loading cases where the dam was unstable. Each of these cases involved uplift on the base of the dam due to hydrostatic forces in combination with the PMF, seismic loadings or ice loadings. Only the ice load occurs in a normal operating situation. The condition of uplift is plausible since seepage was observed at the juncture of the masonry spillway with the bedrock.

It is recommended the following remedial measures be completed within two years:

1. The seepage condition and leakage of the dam should be eliminated by sealing deteriorated mortar joints and open joints.

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able to retain stability under realistic loading conditions which include hydrostatic uplift.

3. The low level outlet should be moved from its present position below the center of the spillway or provided with some means of remote control of the valve controlling the outlet.

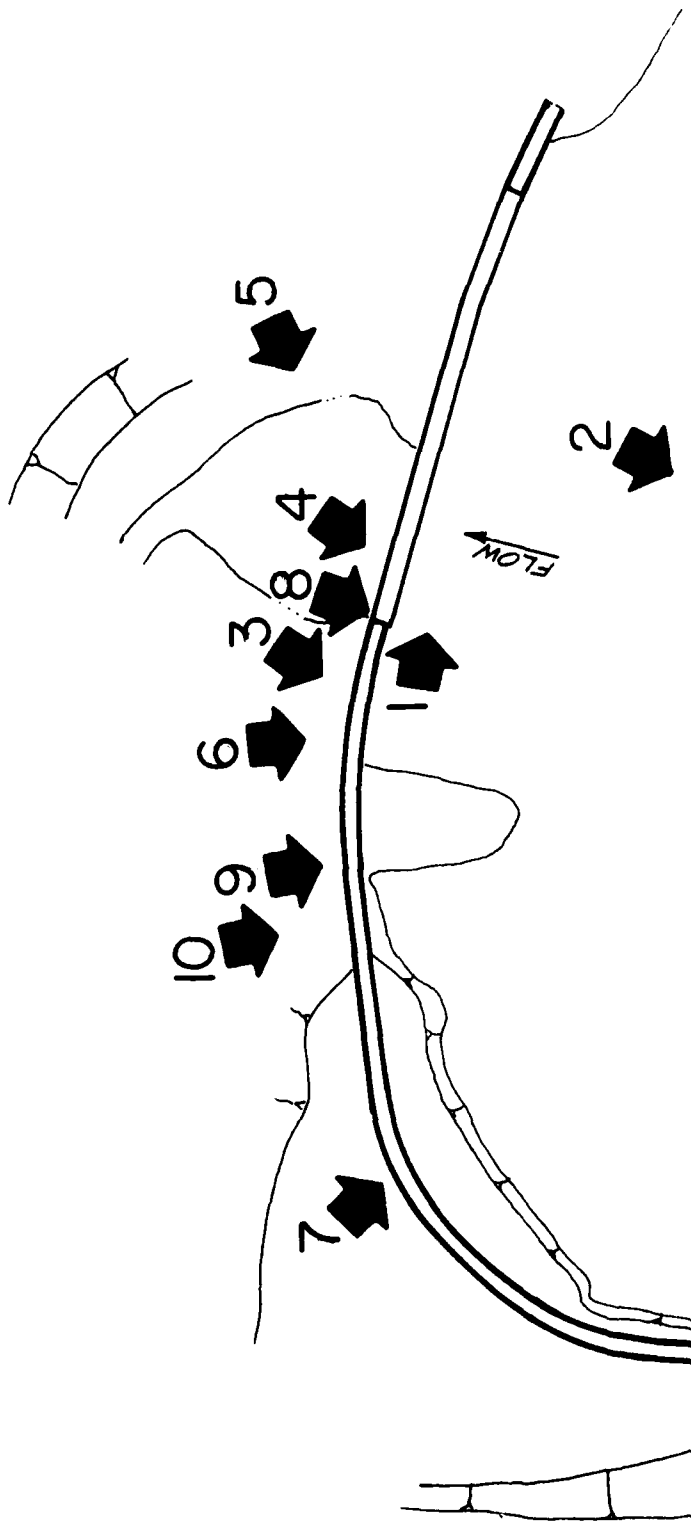
4. The dam should continue to be drawndown in the winter to reduce ice pressure effects on the dam until such time as the dam is repaired.

Dale Engineering Company

John B. Stetson, President

Approved By:
Date: 14 Feb 80

Col. Clark H. Benn
New York District Engineer



PHOTOGRAPH KEY MAP

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1. Close-up view across spillway section with reservoir in drawn down condition.

2. Upstream view of reservoir in partly drawn down state.

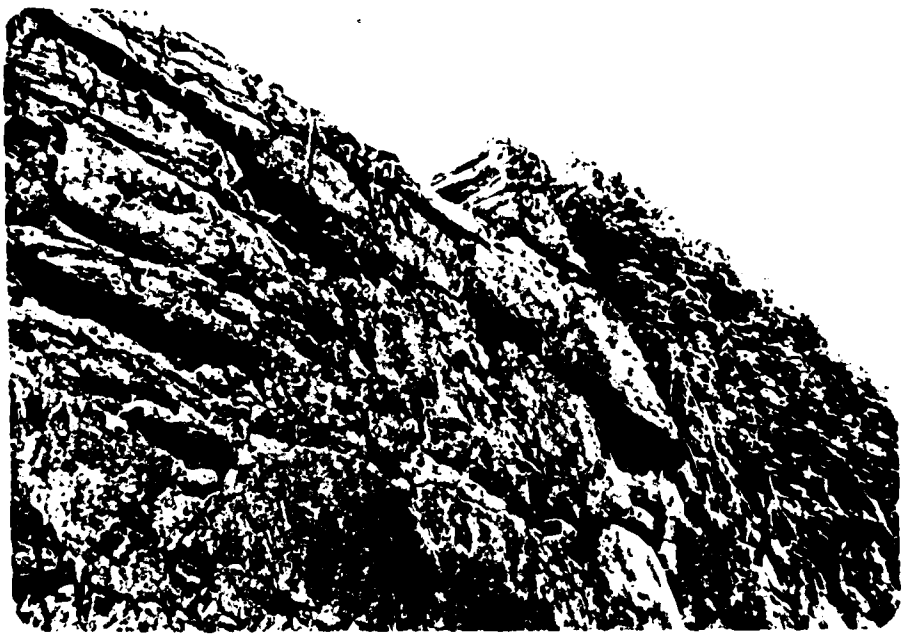
3. Drawn down outlet pipe. Note seepage along base of wall with reservoir partially drawn down. Moss on wall is below spillway section.

4. The laid up masonry dam appears to be resting on bedrock.

5. View across downstream face of spillway area.

6. Close-up of portion of downstream face where masonry has separated from wall.

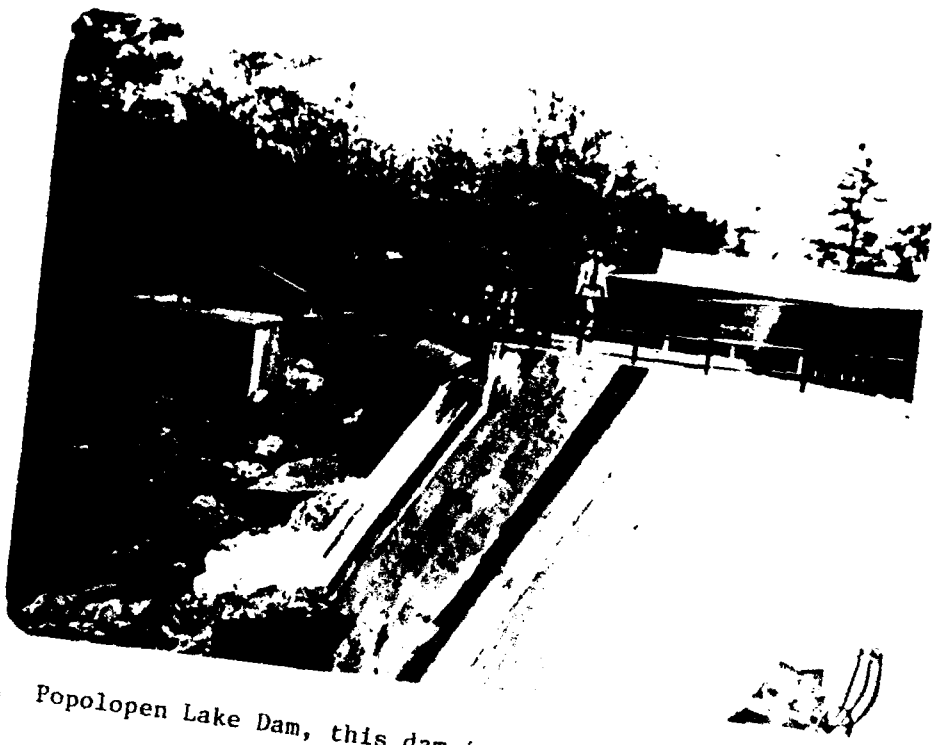
7. Exposed rock at base of wall on north downstream face of dam.



8. Close-up of spillway wall area.

9. Close-up wall section apart from spillway area which is still in good condition.

10. Seepage area below dam just north of spillway area.



11. Popolopen Lake Dam, this dam is upstream of Mine Lake Dam.

12. Stillwell Lake Dam Spillway, this dam is downstream of Mine Lake Dam.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM - MINE LAKE DAM ID# - NY767

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

Authority for this report is provided by the National Dam Inspection Act, Public Law 92-367 of 1972. It has been prepared in accordance with a contract for professional services between Stetson-Dale and The U.S. Army Corps of Engineers.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Mine Lake Dam and appurtenant structures, owned by the United States Military Academy and to determine if the dam constitutes a hazard to human life or property and to transmit findings to the Corps of Engineers.

This Phase I inspection report does not relieve an Owner or Operator of a dam of the legal duties, obligations or liabilities associated with the ownership or operation of the dam. In addition, due to the limited scope of services for these Phase I investigations, the investigators had to rely upon the data furnished to them. Therefore, this investigation is limited to visual inspection, review of data prepared by others, and simplified hydrologic, hydraulic and structural stability evaluations where appropriate. The investigators do not assume responsibility for defects or deficiencies in the dam or in the data provided.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

The Mine Lake Dam is a masonry gravity dam which is constructed on a bedrock foundation. The overall length of the dam is approximately 516 feet. The dam is approximately 13.9 feet high at its highest point near the center of the principal spillway. The principal spillway is located near the south abutment and is approximately 143 feet wide. The spillway is a broad crested weir with a top width of approximately 5 feet. At the time of the inspection, the reservoir was drawn down approximately 5 feet below the elevation of the principal spillway exposing an earth fill area on the upstream face of the masonry dam. This earthen material sloped gently into the impoundment at a slope of approximately 6 feet horizontal to 1 foot vertical. The material near the masonry dam was granular in nature while the material at the water's edge was fine silt. There is no evidence of riprap on this earthen slope. At the time of the

inspection, the butterfly valve which controls the drain line from the impoundment was fully open allowing the impoundment to recede to a low level. The receiving stream immediately downstream from the spillway section is formed in bedrock and is overgrown with trees but shows no recent signs of erosion. The stream empties into Stillwell Lake, a short distance from the Mine Lake Dam.

b. Location

The Mine Lake Dam is located on the West Point Military Reservation in the Town of Highland, Orange County, New York.

c. Size Classification

The maximum height of the dam is approximately 14 feet. No data is available regarding the storage capacity of the impoundment. The estimated storage capacity of this impoundment is 235 acre feet. Therefore, the dam is in the Small Size Category as defined by The Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification

There are no permanent residences downstream from the Mine Lake Dam. The receiving stream runs through the West Point Military Reservation, there are a few structures for intermittent human habitation located along the receiving stream. Therefore, the dam is in the Significant Hazard Category as defined by The Recommended Guidelines for Safety Inspection of Dams.

e. Ownership

The dam is located on the West Point Military Reservation and is therefore owned by the United States Government.

f. Purpose of Dam

The impoundment formed by the Mine Lake Dam is used as a training area and for recreational purposes such as boating and fishing. There are no swimming facilities on Mine Lake.

g. Design and Construction History

The Mine Lake Dam was reputedly constructed in 1846. The facility was reputedly designed by Alexander Potter Associates, New York City. There is no information available regarding the design or construction of the dam. The Facilities Engineer at the United States Military Academy became concerned about the condition of the dam during the summer of 1978 when an inspection disclosed numerous leaks through the masonry structure. At that time, the outlet of the dam was opened and an attempt was made to maintain the impoundment at a low level. The drain line, however, is of inadequate capacity to maintain a low water level during rainfall events.

h. Normal Operating Procedures

The drain line valve is presently maintained in an open condition to attempt to minimize the leakage through the dam by maintaining a low water level in the impoundment. There are no other operating procedures in effect for this facility.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of Mine Lake Dam is 8.73 square miles.

b. Discharge at Dam Site

No discharge records are available for this site.

Computed discharges:

Ungated spillway, top of dam	1,493 cfs
Ungated spillway, PMF	15,070 cfs
1/2 PMF	7,170 cfs
Gated drawdown	--- cfs

c. Elevation (Based on an Estimated USGS Datum)

Top of dam	651.1
Maximum pool - PMF	654.9
1/2 PMF	653.0
Spillway crest	648.7
Stream bed at centerline of dam	634.8

d. Reservoir

Length of normal pool	1800± FT

e. Storage

Top of dam	235± Acre Feet
Normal pool	184.8± Acre Feet

f. Reservoir Area

Spillway pool	25± Acre

g. Dam

Type - Masonry gravity dam.
Length - 516 LF.

Height - 13.9 feet.
Freeboard between normal reservoir and top of dam - 2.5 feet.
Top width - 5-6 feet.
Side slopes - N/A.
Zoning - N/A.
Impervious Core - N/A.
Grout Curtain - Unknown.

h. Spillway

Type - Broad crested weir.
Length - 143 feet.
Crest Elevation - 648.7.
Gates - None.
U/S Channel - Reservoir.
D/S Channel - Bedrock.

i. Regulating Outlets

Drain - 18 inches cast iron pipe with butterfly valve at the outlet end. Elevation - 637.5.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

There is no engineering data available for review on the Mine Lake Dam. A survey of the dam was provided by the Facilities Engineer. This survey was conducted in 1943 by the Office of the Quarter Master at the United States Military Academy at West Point. A similar survey was conducted as a part of this inspection and is included in the report. A cross section of the dam was developed from the data collected during this survey. However, the upstream face of the dam was exposed for only a short distance below the spillway crest elevation. The dam section was estimated using the slope of this upstream face.

2.2 CONSTRUCTION

No information was available regarding the construction of the dam.

2.3 OPERATION

See Section 4.

2.4 EVALUATION

At present, the dam is in poor condition and numerous leaks are noted in the masonry of the dam. However, due to the age of the structure, additional research for data on the structure is not warranted at this time.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The Mine Lake Dam was inspected on May 16, 1979 by the Stetson-Dale Inspection Team. The Inspection Team was accompanied on the inspection by R. Hunjan, Assistant Facilities Engineer from the United States Military Academy at West Point. A field survey of the Mine Lake Dam was conducted on April 24, 1979 by a survey crew from Stetson-Dale. A second inspection of the dam was conducted on June 21, 1979, in order to observe the facility in a full pool condition.

b. Dam

The survey of the dam and spillway system are shown in Figures 2 and 3. The dam is constructed of masonry on a foundation of bedrock. There is no data available regarding the details of the contact with the foundation. The south abutment of the dam is a low masonry section approximately 30 feet long and is founded on bedrock. The spillway extends from this short section 143 feet across the receiving stream. The masonry near the north end of the spillway shows some evidence of displacement near the top of the dam. The downstream face of the dam is, however, in uniform alignment and shows no evidence of any general displacement of the structure. The mortar joints on the downstream face are generally deteriorated leaving cracks and crevices between the stone. At the time of the May 16th inspection, there was no evidence of seepage through the face of the dam. However, the survey which was conducted while the reservoir was at a high level shows the location of many points of seepage through the front face of the dam. The inspection of the dam on June 21 also disclosed seepage through the face of the dam. The water level at the time of the inspection was approximately 5 feet below the level of the principal spillway. There is evidence of general seepage below the dam in many areas, even with the lowered reservoir level. The upstream face of the dam is visible to a point approximately 5 feet below the top of the spillway. The mortar joints in this area are in better condition than the downstream face. Upstream of the dam, there is evidence of a backfill material having been placed against the upstream face. This material is gravelly near the dam but has a very wet and silty characteristic near the water's edge.

c. Spillway

The spillway is a broad crested weir 143 feet long. The vertical alignment of the spillway is fairly irregular and is shown in detail in Figure 2. Figure 3, an elevation view of the masonry in the spillway area, shows the location of the leakage through the dam. The spillway crest is formed in concrete and is deteriorated in various points along the length of the spillway. The width of the spillway crest is approximately 6 feet.

d. Appurtenant Structures

Near the north abutment of the dam, there is located a foundation that originally housed an outlet from the dam. There is no present evidence of an active outlet in this area. A 6-inch cast iron pipe extends out of the ground approximately 8 feet near the base of this foundation area. No other information is available regarding the past use or present function of this section of the dam. It may be noted that a substantial flow channel exists near this abutment and begins at a point where considerable leakage was noted when the survey was conducted. At the time of the inspection, this channel was dry and its exact source was undetermined.

e. Reservoir Area

The reservoir area is generally wooded along the banks. A major highway traverses across the west end of Mine Lake. Numerous outcrops of rock are in evidence along the shoreline. The shore slopes gently away from the reservoir's edge. There is no evidence of bank instability around the reservoir.

f. Downstream Channel

The channel downstream from the dam is founded in bedrock. There is no evidence of recent erosion along the channel. The Stilwell Reservoir is located approximately 200 feet downstream from the dam.

3.2 EVALUATION

The visual inspection reveals that the masonry in the dam is in generally deteriorated condition and that seepage is occurring through the dam while the reservoir is at a high level. With the reservoir at a drawdown condition, seepage continues between the dam and it's foundation. The reservoir drain line is not able to maintain the draw down condition during rainfall events.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

An inspection of the dam by the Facilities Engineer of the United States Military Academy at West Point during the summer of 1978, disclosed seepage through the dam. The drain line to the dam was subsequently opened to attempt to maintain a low level in the reservoir and eliminate loading on the dam. The present procedure is to leave the dam in the drawn down condition until remedial work can be undertaken. There are no other operating procedures appropriate to this facility.

4.2 MAINTENANCE OF THE DAM

The inspection indicates that the dam has been maintained periodically throughout the years. The Facilities Engineer of the United States Military Academy at West Point provides periodic inspection of the facility and exercises general observation of the facility.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 DRAINAGE BASIN CHARACTERISTICS

Mine Lake dam is located along Popolopen Brook and lies between two other man made lakes, Popolopen and Stilwell, both over which have dam structures. The brook below Stilwell Lake discharges into the Hudson River just below Fort Montgomery. The watershed is approximately 8.7 square miles, the terrain is mostly wooded with rock outcropping, lakes and swampy areas. The watershed is largely on the West Point Military Reservation and is to the south and west of the cantonment area.

Two previous inspection reports for Popolopen Lake Dam and Stilwell Lake Dam prepared under this Dam Inspection Program provides data on the drainage basin characteristics.

5.2 ANALYSIS CRITERIA

The purpose of this investigation is to evaluate the dam and spillway with respect to their flood control potential and adequacy. The dam's stability and flood discharge capacity is assessed through the evaluation of the Probable Maximum Flood (PMF) for the watershed and the subsequent routing of the flood through the dam's spillway system.

The PMF event is that hypothetical flow induced by the most critical combination of precipitation, minimum infiltration loss and concentration runoff of a specific location that is considered reasonably possible for a particular drainage area. Since this dam is in the Small Dam Category and is a Significant Hazard, the guidelines criteria (Ref. 1) require that the dam be capable of passing one-half the Probable Maximum Flood.

The hydrologic analysis was performed using the unit hydrograph method to develop the flood hydrograph. Due to the limited scope of this Phase I investigation, certain assumptions, based on experience and existing data were used in this analysis and in the determination of the dam's spillway capacity to pass the PMF.

The U.S. Army Corps of Engineers, Hydrologic Engineering Center's Computer Program HEC-1DB was utilized to evaluate the PMF hydrology. The Probable Maximum Precipitation (PMP) was 22 inches according to Hydrometeorological Report (HMR #33) for a 24 hour duration, 200 square mile basin. Loss rates adopted for the analysis were 1.0

initial abstraction, and 0.1 inches/hour continuous loss rate. Snyder method unit hydrograph characteristics were used. The drainage basin was divided into seven sub-areas, one for each lake subbasin; and four sub-areas below the dams, to evaluate downstream flood flows.

	PMF	1/2 PMF
At Popolopen Dam	9,460	4,680
At Mine Lake Dam	15,070	7,170
At Stilwell Lake Dam	20,250	9,460

5.3 SPILLWAY CAPACITY

The stone masonry dam spillway is an overflow spillway. The spillway length used for the computation was 143 feet and the discharge coefficient was 3.2 at elevation 648.7. The top of dam which was also stone was an elevation 650.9 with a length of 373 feet, a discharge coefficient of 2.64 was used there. The spillway capacity at top of dam was 1,493 cfs.

SPILLWAY CAPACITY

	Discharge	Capacity
PMF	15,070	9.9%
1/2 PMF	7,170	20.8%

5.4 RESERVOIR CAPACITY

No drawings were available for this investigation. Topographic information described from USGS mapping computed the reservoir storage to be around 225 acre feet. At the 1/2 PMF stage, the reservoir total storage is 340 acre feet.

5.5 FLOOD OF RECORD

According to previous inspection reports dated December 1978, flow records in the Wallkill River Basin indicate that the worst flood recorded was October 16, 1955. There are no stream gages or records of major floods for the Popolopen Brook Watershed.

5.6 OVERTOPPING ANALYSIS

The HEC1-DB analysis indicates that the dam would be overtopped as follows:

	OVERTOPPING IN FEET
PMF	4.0
1/2 PMF	2.1

No significant effect would be realized downstream. The PMF would pass through Stilwell Reservoir with 4 feet of freeboard remaining.

5.7 EVALUATION

The dam has no flood mitigation capability. Overtopping could occur at less than 10 percent of the PMF. The spillway is therefore rated inadequate. Since the dam is classified as a Significant Hazard, The Corps of Engineers screening criteria for a severely inadequate spillway does not require measures to improve spillway capacity.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations And Data Review

The masonry structure (stone and mortar) was observed by members of the inspection team at two different times. The initial inspection occurred with Mine Lake drawn down to a level approximately five feet below spillway elevation. A later inspection was performed after the lake level had been permitted to raise to near spillway elevation.

Reportedly, the dam structure was originally constructed at this location some 133 years ago in 1846 but no information is available concerning the design or construction. It is not known if the present dam is representative of the original construction, or if it has been enlarged/rebuilt to any extent. Conversations with Corps of Engineers personnel at the West Point Military Reservation imply the belief that the dam could have been a dry, layed-up stone structure. Joint mortar may have been provided at some post-construction time.

The dam's face material consists essentially of large stone. It appears that the dam stone is founded directly on the areas bedrock (exposed throughout the downstream area. As a structure, the dam appears stable, with no indication of misalignment, tilting or lateral displacement. Some minor movement of the stones were noted. However, seepage occurs through the face and base of the dam at a number of locations. This seepage is a flowing condition as opposed to a dampness condition but seepage pressures were not great enough to create a spurting condition. The seepage appears to be limited to paths along joints between the structure's stone. At the time of inspection on June 21, flow was largely at the base of the dam. Areas of poor/missing joint mortar are numerous. The still present mortar is generally fair to poor.

Comparing conditions at the time of low lake level to the time of higher lake level, downstream dam face seepage was noticeably much greater at the high water level, an expected condition but also creating the implication that the more significant seepage entry occurs through the upper part of the dam's upstream side. Soil material placed or accumulated against the lower half, approximately, of the dam's upstream side probably acts to retard seepage entry through the dam's lower section.

Examination of the upstream face of the dam's deeper deteriorated joints at a few locations showed no mortar at the more internal locations, but numerous small stones and rock fragments where noted. From this it is felt possible that the structure was originally dry construction with small stone and rock fragments utilized to fill joints to improve the dam's structural strength and resistance to seepage. Mortar application may have been limited to the facial zones, during original construction or some subsequent time.

The mortared stone dam cap is generally in fair condition. Some stone in the cap could have been displaced by ice action. In the dam structure there is little evidence of movement of individual large face stone, an exception being on the downstream face near the southerly abutment. At this location, one large stone in the dam's upper half has experienced noticeable movement. Seepage occurs in the general area, but it is felt the displacement is more the result of ice formation in joints than seepage pressure. The spillway area at the base of the dam is bedrock, but brush and trees exist in a thin soil cover at the base of the dam near the abutment areas.

b. Geology and Seismic Stability

The Mine Lake area lies in the Hudson Highlands, which is part of the Reading Prong. The Reading Prong is an elongate upland of Precambrian igneous and metamorphic rocks which extends southwestward from Connecticut, through southeastern New York and western New Jersey, into Pennsylvania.

The dam is sited on bedrock, which is a hypersthene-quartz-oligoclase gneiss of Precambrian age. Downstream from the spillway the stream channel is in this same bedrock. Where fresh, the bedrock is a green or greenish-buff color; weathered surfaces are white to light gray. Subordinate amounts of biotite, amphibole and pyroxene are present in the gneiss. Bedrock foliation strikes from N 35 degrees E to N 45 degrees E and dips generally 60 degrees SE. The dam orientation is roughly parallel to the rock foliation.

Blocks of gneiss make up the dam structure and were laid with the foliation planes oriented in various directions relative to the face of the dam. Block foliation was laid either parallel to the face or perpendicular (both vertical and horizontal) to the dam face. These blocks are weathered badly in places to the extent that specimens are easily removed and are rotted to the extent that they may easily be crushed by hand.

Although gneiss is generally considered to be relatively impervious and to have considerable strength and bearing capacity, weathering of pyroxene (hypersthene) and plagioclase (oligoclase) as well as any biotite and amphibole present may yield rotted zones which could permit seepage. Such occurrences would contribute to the seepage and flow noted along and beneath the dam face, particularly where the foliation planes of the blocks in the dam are perpendicular to the face.

Mortar used for laying up the blocks of gneiss on the dam is badly deteriorated. Specimens of this mortar are easily crushed by hand in some cases. Petrographic analyses of the mortar shows the aggreate make-up to be of poor quality. Grains of minerals (quartz, amphibole, pyroxene, biotite and feldspar) and rock (slate and gneiss) are present. Leached out cavities are also present. The calcareous portion is also badly weathered in places. The aggregate make-up of the mortar would contribute readily towards mortar deterioration. The poor condition of the mortar may be the major cause of seepage and leakage through the dam. As noted previously, weathering of some portions of the dam blocks also could allow for some seepage.

The area is designated as being in Zone 1 of the Seismic Probability Map. Because the area is located within the Ramapo fault system, the New York State Geological Survey believes this region should be upgraded to a Zone 3. As shown on Geologic Structures Map 1, numerous faults are known to exist in the vicinity of Mine Lake. Several significantly large faults are also known to exist beyond the boundaries of Geologic Structures Map 1. Numerous additional lineaments, not shown on this map, but shown on the Preliminary Brittle Structure Map of New York of the New York State Geological Survey (1977), may indicate additional fault or shear zones are present in this area. A shear zone is indicated as being perpendicular to and beneath the dam at Stillwell Lake.

Agaarwal and Sykes (1978) believe the Ramapo fault is capable of generating an earthquake of at least intensity VII (Modified Mercalli scale). Their map has been reproduced here as Geologic Structures Map 2. The dam location is northeast of the map center and west of the Ramapo fault.

Seven earthquakes have been recorded from within a 20 mile radius of the dam. One earthquake located 11 miles to the north and recorded in 1878, had an intensity of V; another recorded in 1941, about 12 miles to the southwest, also had an intensity of V. The most recent earthquake, intensity about I, occurred 4 miles to the northeast.

c. Stability Evaluation

Field observations and materials evaluation indicate that although the structure has managed to maintain stablity under past loading conditions the dam leaks significantly and the rock and mortar materials have deteriorated to an extensive degree with deterioration expected to progress, probably at an increasing rate.

To obtain an indication of the potential for rehabilitating the present structure, on the assumption repair to reduce seepage and rock materials deterioration could be accomplished, stability analyses have been performed. Since information relating to the as-built condition of the dam has been limited to observation surveys conducted as part of the present study, a number of assumptions have been made regarding properties of materials and the dam geometry. Accordingly, the indicated stability factors of safety summarized in the table below should be considered as order-of-magnitude, to use as a guide in anticipating the stability behavior for a particular combination of loading conditions.

The analysis has treated the dam structure as a monolith, a condition not accurately representative of existing conditions but which could represent a properly rehabilitated structure. Where significant leakage through a dam does occur, the water pressures behind the structure are expected to be somewhat less than full hydrostatic pressure assumed for a non-leaking monolith. Conversely, where

seepage occurs, water pressures internal to the dam could effect structural strength and ability to resist external forces acting at certain points. In the analysis for the monolith, it has been assumed that the strength of materials in the structure would be adequate to resist internal shears and bending moments occurring because of loading. The results of the analysis are summarized below. The analysis are included in Appendix D.

RESULTS OF STABILITY COMPUTATIONS

Loading Conditions	Factory of Safety* Overturning	Sliding
(I) Reservoir level at spillway elevation		
(i) uplift on base, no ice acting	1.6±	9± (friction shear method) 1.7± (friction only, no shear)
(ii) no uplift, ice one foot thick acts	1.4±	1.2± (friction only, no shear)
(iii) uplift plus ice one foot thick	0.9±	0.87± (friction only, no shear)
(II) Reservior level at PMF elevation		
(i) uplift on base	0.9±	4.3± (friction shear method) 0.64± (friction only)
(ii) no uplift	2.0±	1.15± (friction only)
(III) Reservoir level at spillway elevation, with earthquake forces acting (utilizing seismic coefficients applicable to Zone 3 Probability Area)		
(i) uplift, no ice	1.26±	---
(ii) no uplift, ice one foot thick	1.13±	---
(iii) uplift, plus ice one foot thick	0.78±	---

*These factors of safety indicate the ratio of moments resisting overturning to moments causing, and the ratio of forces resisting sliding to those causing sliding; a ratio less than unity indicates instability. The analysis considered the level of the downstream pool to be at the base of the dam section.

The analyses indicate unsatisfactory stability against overturning and sliding for certain combinations of loading, including normally expected conditions.

Critical to the analysis and resulting indication of stability are the items of uplift water pressures acting on the foundation of the dam and the permeability of the foundation site's rock. The analysis uplift force was based on full headwater hydrostatic pressure acting at the dam's foundation upstream corner and a zero tail water hydrostatic pressure acting at the dam's downstream corner, with the resulting triangular force pattern applied to 100 percent of the dam section. On the basis of the observed seepage at the time of the field inspections and possibility of rotted zones in the bedrock permitting seepage, it is felt the uplift assumptions are reasonable in lieu of the absence of actual field measurements.

The lake level has been drawn down at times in the recent past because of concern over stability. Utilizing the results of the analysis as a guide, it would be prudent to maintain the lake at a drawn down elevation, particularly in winter.

Practical means to improve the stability against overturning and sliding include increasing the mass (cross section) of the present dam by the addition of concrete or rock or earth fill to the upstream and/or downstream sides. Grouting or other means to seal deteriorated mortar joints and open joints is also recommended to improve the internal strength of the dam structure and also to prevent the effects of seepage such as ice damage and erosion. Where additional materials are utilized to increase the mass of the dam, the design and construction should consider the need to include protection against wave action, overflow and erosion.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

The Phase I inspection of Mine Lake Dam did not indicate conditions which constitute an immediate hazard to human life or property. Under present normal operating conditions, the dam is not considered to be unstable. However, conditions could occur where uplift forces on the dam in combination with either ice loads, a PMF event, or seismic loading could cause instability. In addition, the spillway capacity of 1,493 cfs is only 9.9% of the PMF. The computed PMF is 15,070 cfs while the 1/2 PMF is 7,170.

The following specific safety assessments are based on the Phase I visual examination analysis of hydrology and hydraulics, and structural stability:

1. The dam appears stable, with no indication of misalignment, tilting or lateral displacement. Some minor movement of the stone was noted.

2. Seepage was observed at the base of the dam at the juncture with bedrock at a number of locations. Considerable flow was noted through the dam.

3. A low level outlet pipe controlled by a butterfly valve is located immediately below the spillway. This is a difficult location to operate the valve.

4. The mortar in the stone work was in fair to poor condition. The upstream face of the dam had deep deteriorated joints at a few locations. Inspection of these areas showed no mortar in the more internal locations. The conclusion was that the mortar was facial.

5. The mortared stone dam cap is in fair condition. Seepage through these joints may be due to ice formations in the joints. A petrographic analysis determined the aggregate make-up to be poor quality.

6. The stone in the dam is gneiss and is weathering. Rotted zones within the stone may have contributed to the seepage.

7. Seismic records indicate that this area should probably be classified as Zone 3, wherein seismic forces should be evaluated in the dam's stability.

8. The dam, which is probably layed up stone work with a rubble center, was analyzed for stability as a monolith, a condition which may not accurately represent of the dam's current condition.

b. Adequacy of Information

The information available is adequate for Phase I inspection purposes. No plans or design information was available to use in the investigation.

c. Urgency

The spillway capacity is severely limited and the dam leaks. This condition added to the structural instability with hydrostatic uplift forces under either ice, PMF, or seismic loadings, establishes that design work for repair of the dam should be initiated within the next 6 months with repairs to be completed within 2 years.

d. Need for Additional Information

No additional information is needed to perform this assessment.

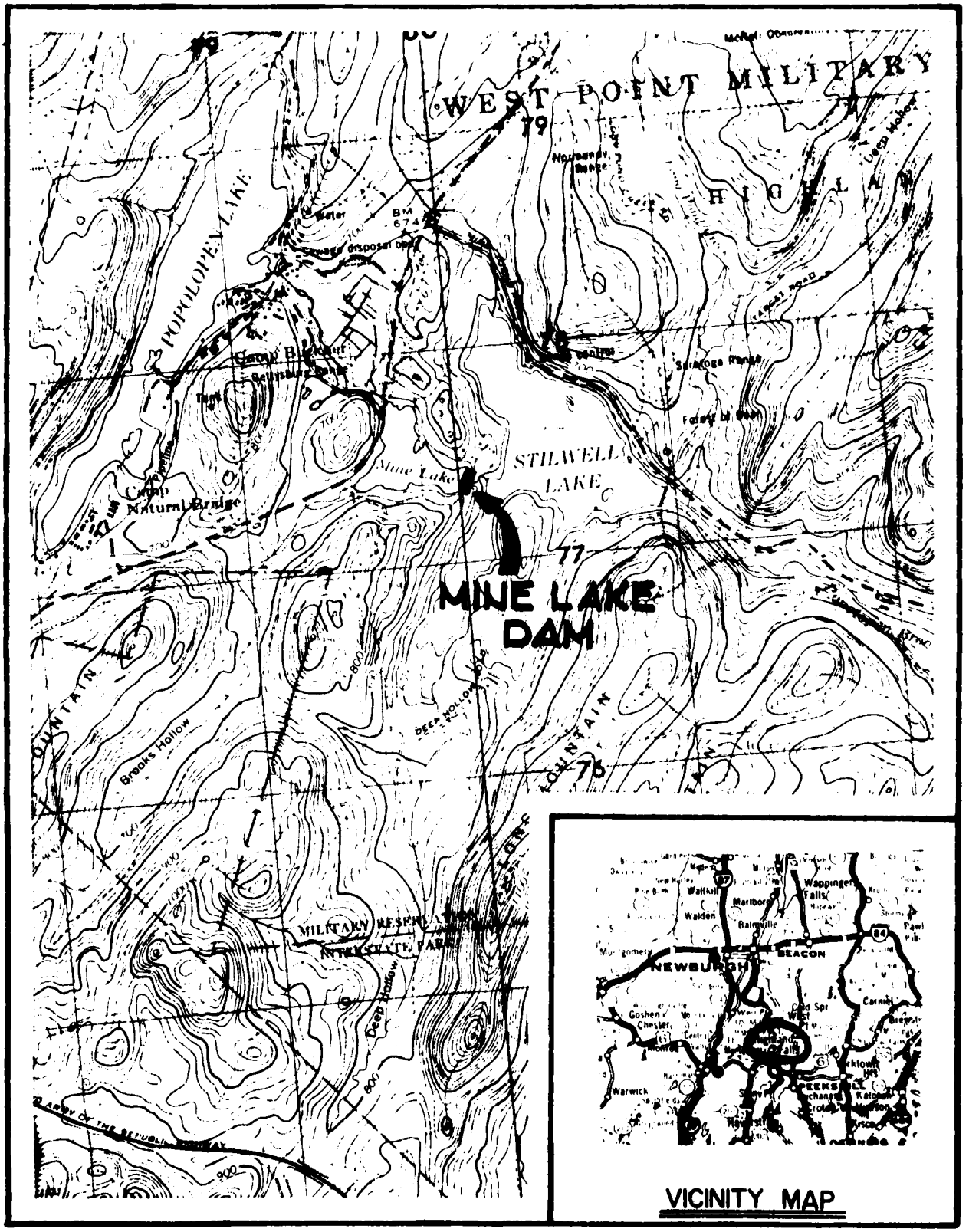
7.2 RECOMMENDED MEASURES

a. The seepage condition and leakage of the dam should be eliminated by sealing deteriorated mortar joints and open joints.

b. Steps should be taken to ensure the dam acts as a monolith. Additional material should be added to the section to increase stability. Since seismic forces are a possibility, the dam section should be redesigned to retain stability under realistic loading conditions which include hydrostatic uplift.

c. The low level outlet should be moved from its present position below the center of the spillway.

d. The dam should continue to be drawndown in the winter to reduce ice pressure effects on the dam until such time as the dam is repaired.



LOCATION PLAN

FIGURE 1

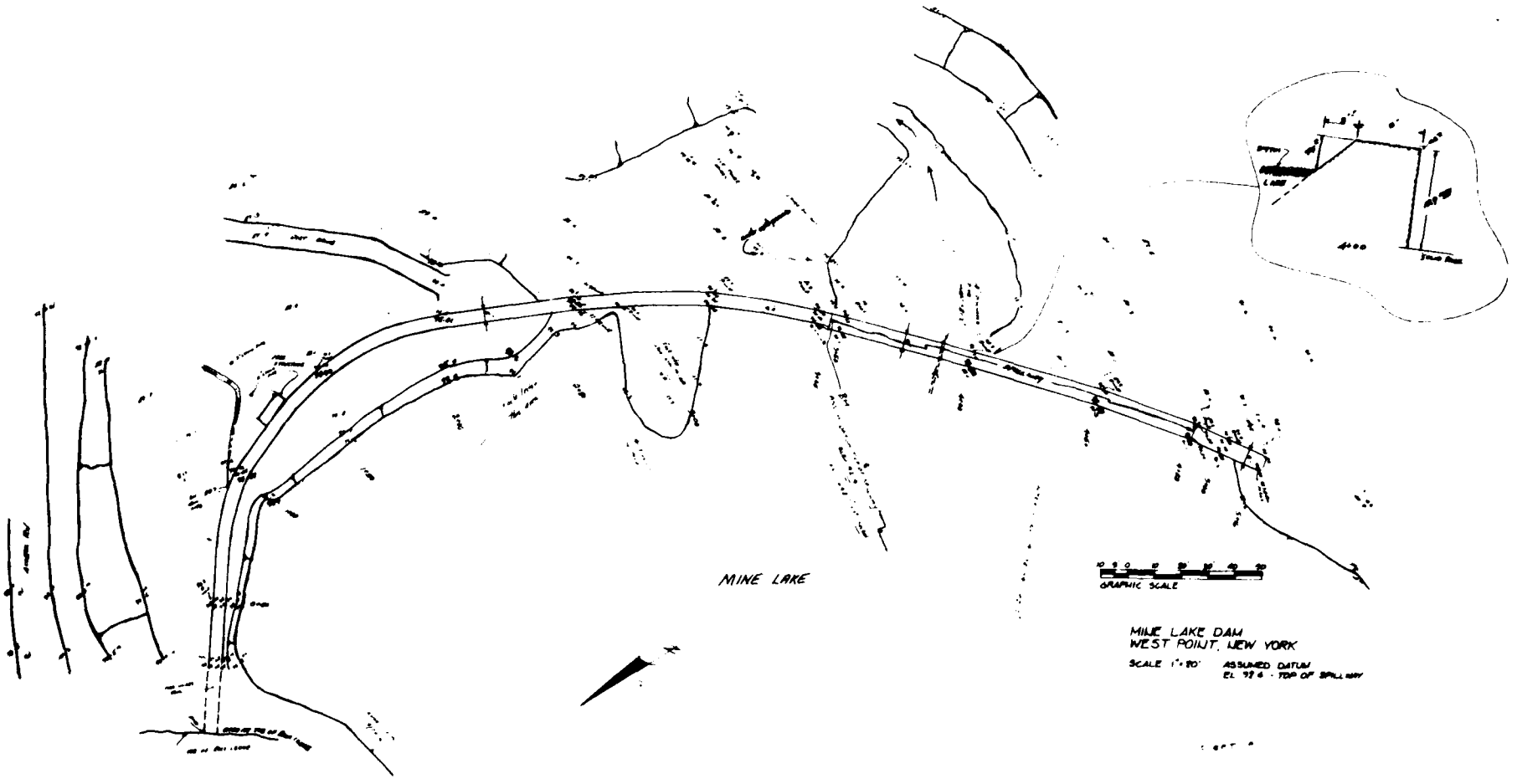
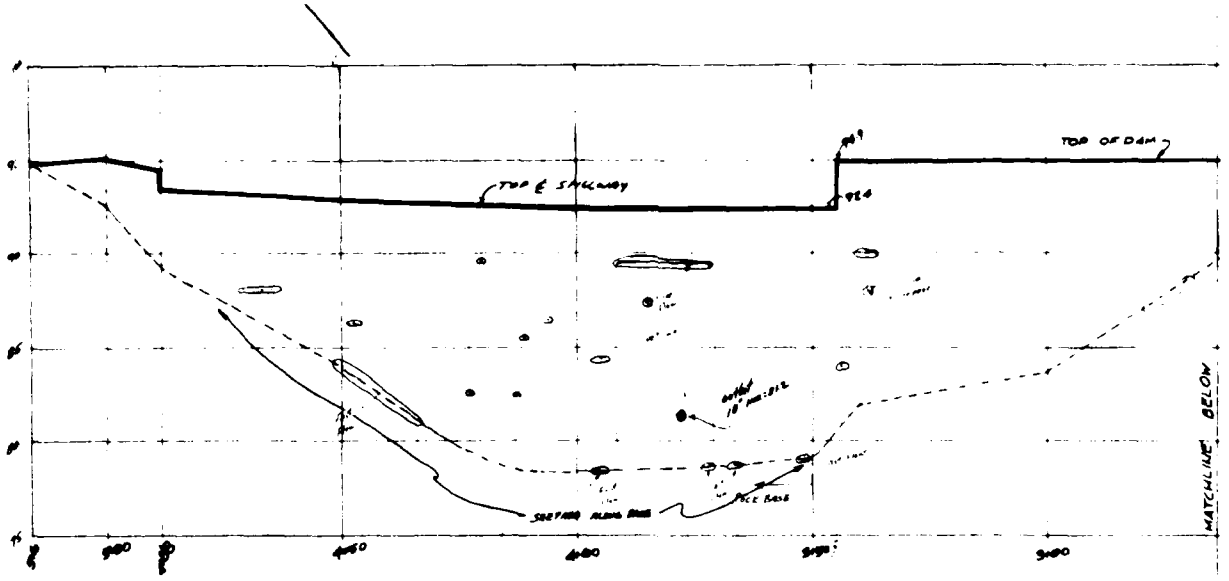
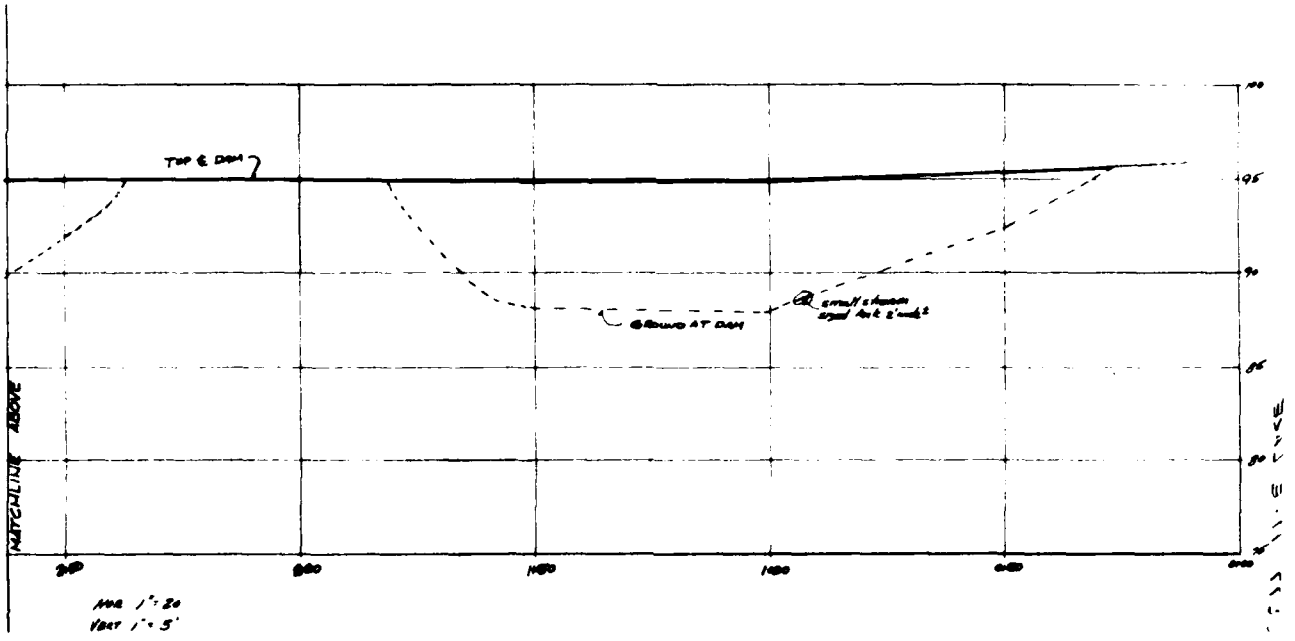

MINE LAKE
GRAPHIC SCALE
MINE LAKE DAM
WEST POINT, NEW YORK
SCALE 1"=80'

FIGURE 2





1" = 20'
1" = 5'

10' 5' 0 10' 20' 30' 40'

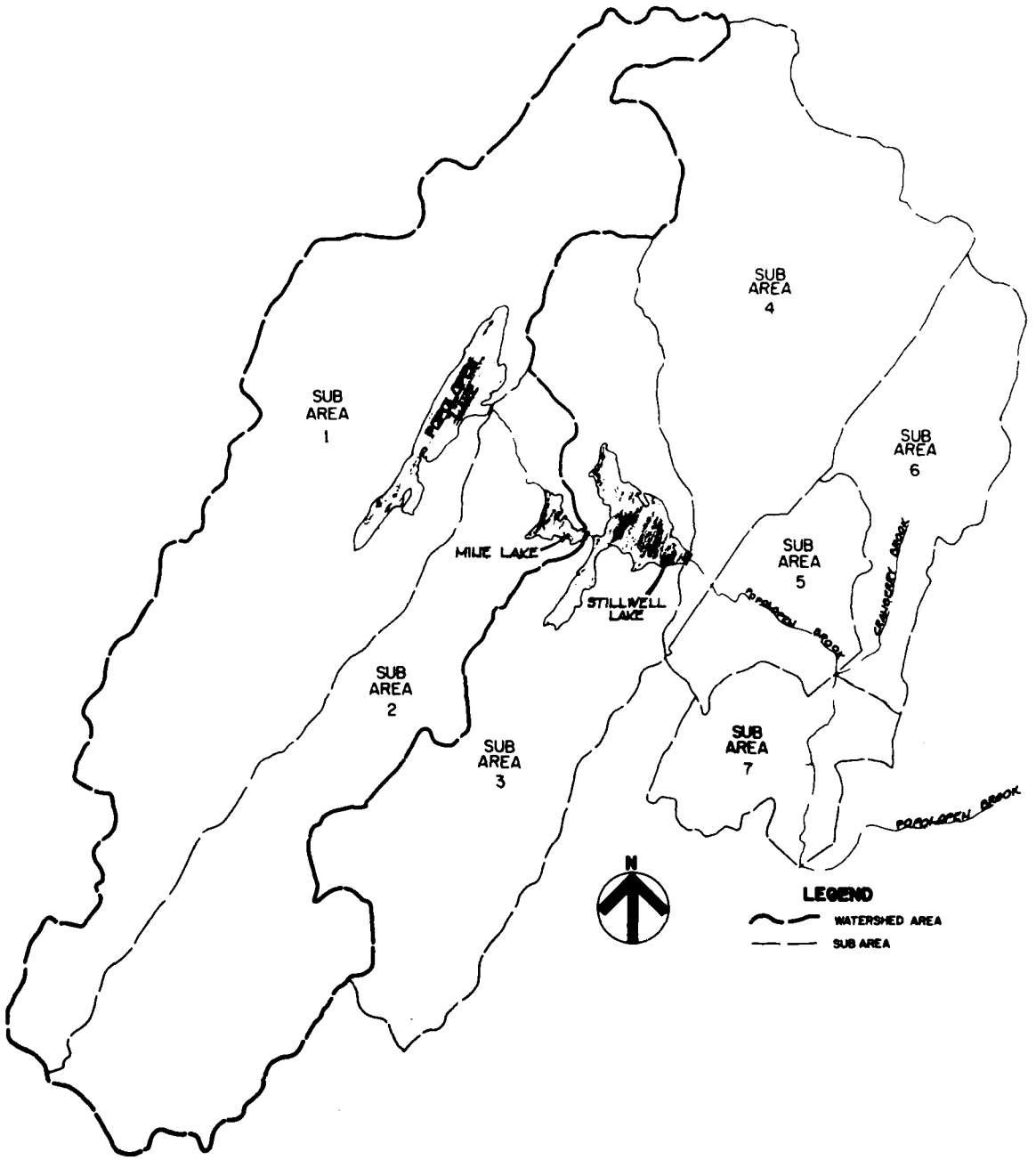
1' 0 1' 2' 4' 6' 8' 10'

GRAPHIC SCALE

MINE LAKE DAM
WEST POINT, NEW YORK
SCALE: 1" = 20' HORIZONTAL
1" = 5' VERTICAL

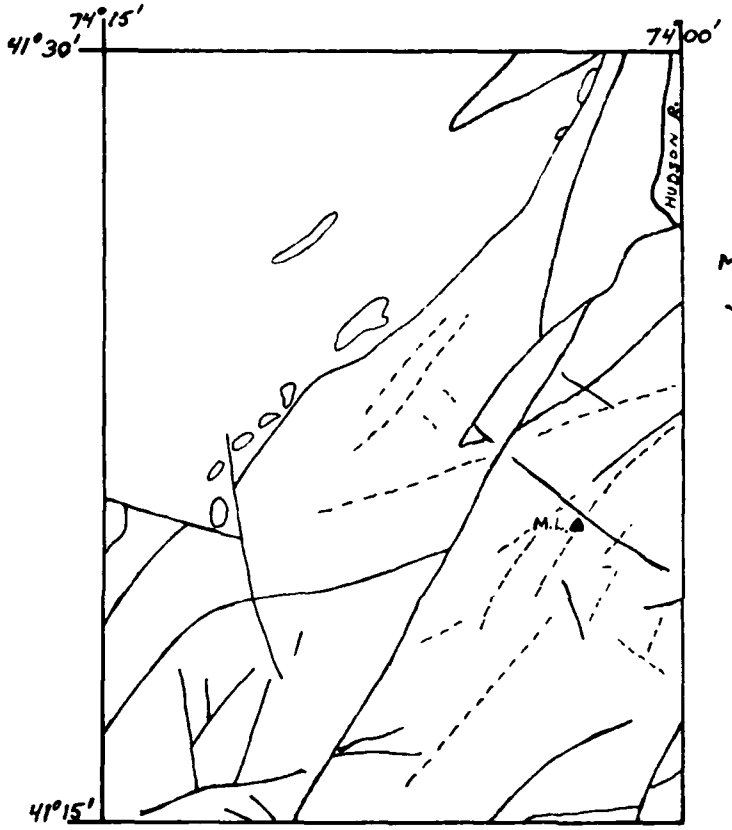
SHEET 1 OF 2

FIGURE 3



DRAINAGE BASIN PLAN

FIGURE 4



LEGEND

M.L. ▲ - MINE LAKE

YO FAULT LINES
from
N.Y.S. Geologic Map (1970)
N.Y.S. Geologic Survey
Preliminary Brittle
Structures Map (1977)

LINEAMENTS
from
Brittle Structures
Map (1977)

GEOLOGIC STRUCTURES
MAP 1

FIGURE 5

STETSON • DALE

DATE	DRAWN
7·19·79	HM
JOB 2277	APP'D

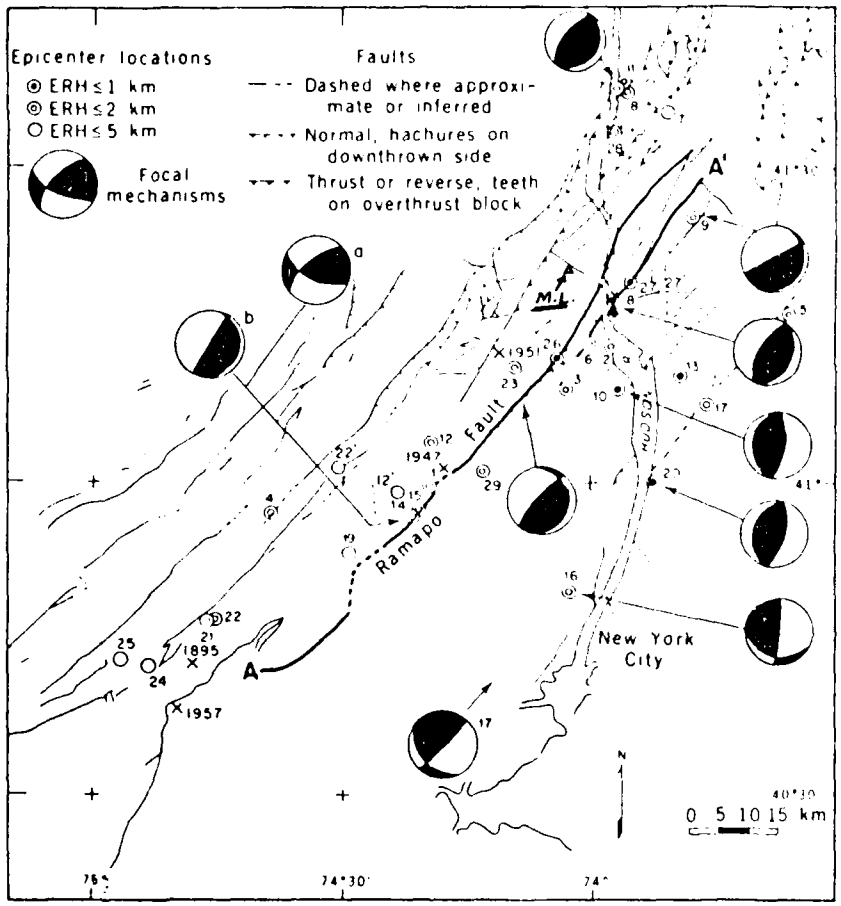


Fig. 2. Fault map (4, 5, 29) of southeastern New York and northern New Jersey showing epicenters (circles) of instrumentally located earthquakes from 1962 through 1977.

From Aggarwal and Sykes (1977). Mine Lake (M.L. △) located in northeast central part of map.

GEOLOGIC STRUCTURES

MAP 2

FIGURE 6

STETSON • DALE	DATE 7.19.79	DRAWN HM
	JOB 2277	APP'D

APPENDIX A

FIELD INSPECTION REPORT

CHECK LIST
VISUAL INSPECTION

PHASE 1

Name Dam Mine Lake Dam County Orange State New York ID # 767

Type of Dam Masonry Hazard Category Significant

Date(s) Inspection May 16, 1979 June 21, 1979 Weather Sunny Temperature 70

Pool Elevation at Time of Inspection 644±1 M.S.L. Tailwater at Time of Inspection ---
(5 feet below spillway)

Inspection Personnel:

N.F. Dunlevy	Stetson-Dale	
F.W Byszewski	Stetson-Dale	
D.F. McCarthy	Stetson-Dale	
H. Muskatt	Stetson Dale	

R. Hunjan — Assistant Chief Civil Engineering Section
Facilities Engineer
U.S. Military Academy, West Point

N.F. Dunlevy Recorder

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Seepage observed at base of spillway section. Moss growth on most of spillway section wall.	Reservoir down about 5 feet below spillway during inspection. A condition of general seepage not discernible. The 21 June inspection observed seepage as shown on surveyed elevation of dam shown in the Figures Section of this Report.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	West abutment founded on rock. East abutment foundation unknown. No deterioration or settlement of abutment observed. No seepage could be ovserved since reservoir was down.	The 21 June inspection noted no seepage at the abutments.
DRAINS	None.	
WATER PASSAGES	None.	
FOUNDATION	No data. Appears to be on rock. Bedrock appears to go under layed rock and rubble masonry spillway section.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Considerable cracking occurring in masonry joints. Concrete pointing deteriorated. Rock weathered. Voids in masonry facing. Some movement in rocks.	Obvious need of repair or replacement. Movement in roacks should be monitored i.e., with spray paint.
STRUCTURAL CRACKING	No cracking of rocks, dam section observed. Concrete masonry work severely cracked at numerous locations.	Obvious need of repair or replacement.
VERTICAL & HORIZONTAL ALIGNMENT	Appears to be in-state constructed. Alignment not as straight as would be constructed to today's standards.	
MONOLITH JOINTS	None.	
CONSTRUCTION JOINTS	None.	
STAFF GAGE OF RECORDER	None.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	N/A.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	N/A.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	N/A.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	N/A.	
RIPRAP FAILURES	N/A.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	N/A.	
ANY NOTICEABLE SEEPAGE	N/A.	
STAFF GAGE AND RECORDER	N/A.	
DRAINS	N/A.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY WEIR	Weir across center of dam. Spills onto bedrock. Center of dam appears to be laid up on rock with rubble in the interior.	
APPROACH CHANNEL	Front of dam silted up.	See photographs in inspection report.
DISCHARGE CHANNEL	Bedrock to 25 feet beyond spillway flows into main channel alsy beyond spillway section.	
BRIDGE AND PIERS	None.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	None.	
APPROACH CHANNEL	None.	
DISCHARGE CHANNEL	None.	
BRIDGE AND PIERS	None.	
GATES AND OPERATION EQUIPMENT	None.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet steel pipes. Discharge onto rock.	Controlled with butterfly valve.
INTAKE STRUCTURE	Thru dam Intake in reservoir approximately 25 feet in front of spillway wall.	
OUTLET STRUCTURE	Steel pipe thru spillway wall.	
OUTLET CHANNEL	Rock.	
EMERGENCY GATE	None.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Some minor debris.	
SLOPES	None into reservoir.	
APPROXIMATE NO. OF HOMES AND POPULATION	None in Palisades Park area below dam. No programmed park activities. Military Reservation has camp area which has limited summer use.	Stream discharges in Hudson River just north of Bear Mountain Bridge. Channel has steep side slopes. Not likely place for park visitors to be.

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Terrain flat surrounding reservoir.	
SEDIMENTATION	Great deal of siltation in old reservoir.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE 1

NAME OF DAM Mine Lake at West Point

ID # 767

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	See this report.
CONSTRUCTION HISTORY	Not known. Believe to have been built by others. Property later acquired by U.S. Government.
TYPICAL SECTIONS OF DAM	See surveyed sections prepared for and included in this report.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See surveyed sections prepared for and included in this report.
RAINFALL/RESERVOIR RECORDS	None given.

ITEM	REMARKS
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None.
POST-CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	None.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	None.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	No data.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	No data.
MAINTENANCE OPERATION: RECORDS	No data.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	See information prepared for this report.
OPERATING EQUIPMENT PLANS & DETAILS	No data.

CHECK LIST
HYDROLOGIC & HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 8.75 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 648.7 feet.

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 648.7 feet.

ELEVATION MAXIMUM DESIGN POOL: ---

ELEVATION TOP DAM: 650.9

CREST:

a. Elevation 648.7 feet
b. Type Stone masonry weir.
c. Width 6 feet
d. Length 143 feet.
e. Location Spillover Center of dam.
f. Number and Type of Gates None.

OUTLET WORKS:

a. Type Steel pipe with butterfly valve.
b. Location Center of dam below spillway section.
c. Entrance Inverts
d. Exit Inverts estimated 637
e. Emergency Draindown Facilities this pipe.

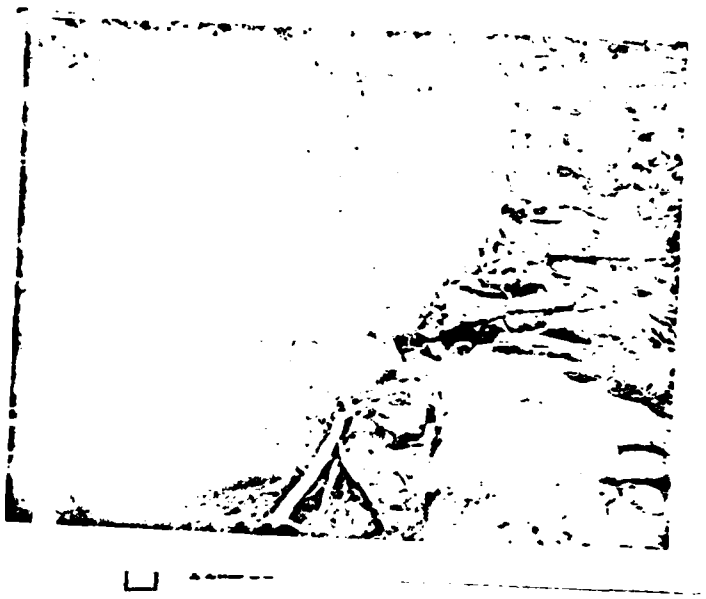
HYDROMETEOROLOGICAL GATES:

a. Type ---
b. Location ---
c. Records ---

MAXIMUM NON-DAMAGING DISCHARGE: N/A

APPENDIX B

PREVIOUS INSPECTION REPORTS/RELEVANT CORRESPONDENCE



Mine Lake

ION REPORT
nspection)

County	Hazard Class*	Date & Inspector
Orange	A	8/21/79 KDH

Use

- [x] Water Supply
- [ ] Power
- [ ] Recreation
- [ ] Fish and Wildlife
- [ ] Farm Pond
- [ ] No Apparent Use-Abandoned

Estimated Impoundment Size

- [ ] 1-5 acres
- [ ] 5-10 acres
- [x] Over 10 acres

Estimated Height of Dam above Streambed

- [ ] Under 10 feet
- [x] 10-25 feet
- [ ] Over 25 feet

Condition of Spillway

- [x] Service satisfactory
- [ ] In need of repair or maintenance

- [ ] Auxiliary satisfactory
- [ ] In need of repair or maintenance

Explain: _____

Condition of Non-Overflow Section

- [ ] Satisfactory
- [x] In need of repair or maintenance Explain: Leakage from between Stones

Condition of Mechanical Equipment

- [x] Satisfactory
- [ ] In need of repair or maintenance Explain: New 18" ± Drain

Evaluation (From Visual Inspection)

- [x] No defects observed beyond normal maintenance
- [ ] Repairs required beyond normal maintenance

*Explain Hazard Class, if Necessary _____

Mine Lake

DAM INSPECTION REPORT
(By Visual Inspection)

03 Dam Number	River Basin	West Fork Town	County	Hazard Class*	Date & Inspector
1957-4[illegible]	Low. Hudson	Highlands	Orange	A	9/21/74 KDH

Type of Construction

- ☐ Earth w/concrete spillway
- ☐ Earth w/drop inlet pipe
- ☐ Earth w/stone or riprap spillway
- ☐ Concrete
- ☑ Stone
- ☐ Timber

Use

- ☑ Water Supply
- ☐ Power
- ☐ Recreation
- ☐ Fish and Wildlife
- ☐ Farm Pond
- ☐ No Apparent Use-Abandoned

Estimated Impoundment Size

- ☐ 1-5 acres
- ☐ 5-10 acres
- ☑ Over 10 acres

Estimated Height of Dam above Streambed

- ☐ Under 10 feet
- ☑ 10-25 feet
- ☐ Over 25 feet

Condition of Spillway

- ☑ Service satisfactory
- ☐ In need of repair or maintenance

- ☐ Auxiliary satisfactory
- ☐ In need of repair or maintenance

Explain: _____

Condition of Non-Overflow Section

- ☐ Satisfactory
- ☑ In need of repair or maintenance Explain: Leakage from between Stones

Condition of Mechanical Equipment

- ☑ Satisfactory
- ☐ In need of repair or maintenance Explain: New 18" ± Drain

Evaluation (From Visual Inspection)

- ☑ No defects observed beyond normal maintenance
- ☐ Repairs required beyond normal maintenance

*Explain Hazard Class, if Necessary _____

August 30, 1974

Colonel C. W. Guth
Directorate of Facilities Engineering
Building 667-B
United States Military Academy
West Point, New York 10996

Re: Mine Lake Dam
Cragston Lake Dam #213-808
Lake Georgena Dam #443
Lower Hudson Watershed

Dear Colonel Guth:

Inspections of the referred to dams were made by Kenneth Harmer in cooperation with your office during the months of July and August, 1974.

The findings are as follows:

The Mine Lake Dam has several leaks through the laid up stone. They are of a minor nature now, however, proper maintenance at this time would alleviate future problems.

The Georgena Dam (#443) has leaks through several cracks and concrete joints in the non-overflow section. As with the Mine Lake Dam, it would be wise to correct the situation within the near future.

The Cragston Lake Dam (#213-808) has a large portion of the concrete-stone spillway completely broken away. The structural integrity of this dam is in serious question. It is recommended that your office examine the structure and take appropriate action in the near future.

Please inform this office as to your intention and/or work performed on the dams mentioned.

Thank you for your cooperation.

Very truly yours,

R. B. Norton, Chief
Bureau of Facilities and
Construction Management

By: Kenneth Harmer

DEPARTMENT OF THE ARMY
UNITED STATES MILITARY ACADEMY
WEST POINT, NEW YORK 10996

MAEN-A

2 October 1974

Mr. R. B. Norton
Chief, Bureau of Facilities
and Construction Management
N. Y. State Department of Environmental Conservation
50 Wolf Road
Albany, New York 12201

Dear Mr. Norton:

This replies to your letter of 30 August 1974 about the inspection of Mine Lake Dam, Cragston Lake Dam No. 213-808, Lake Georgena Dam No. 443, and Lower Hudson Watershed made by Kenneth Harmer of your office.

The dams in question were recently reinspected to determine appropriate work requirements. The following work will be scheduled and accomplished as soon as possible:

Mine Lake Dam - Cut out deteriorated mortar in joints and repoint same. Plug up holes in base of dam where water seeps through.

Georgena Dam (No. 443) - Cut out the loose sections of concrete and replace them with new. Since this lake serves no purpose, I propose to maintain the present water level in this dam which is now approximately four feet below the bottom of the overflow in the spillway. This will reduce the pressure against that part of the dam which is now out of alignment.

Cragston Lake Dam (No. 213-808) - Remove the section of the spillway which has separated from the face of the dam and replace it with poured concrete.

Scheduled monitoring of these dams will be an established requirement to preclude future deterioration.

Your interest and assistance in surveying the USMA dams on the West Point Reservation is greatly appreciated.

Sincerely,

C. W. GUTH
Colonel, CE
Engineer

APPENDIX C

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

STETSON • DALE BANKERS TRUST BUILDING UTICA • NEW YORK • 13501
TEL 315-797-5800

DESIGN BRIEF

PROJECT NAME New York State Dam Inspection — DATE 4.30.79

SUBJECT Mine Lake Dam (West Point, NY) — PROJECT NO 2277

Estimate of Clark's Parameters — DRAWN BY JPG

Estimate of T_c

$T_c = 11.9 \ (L^3/H)^{.385}$

Assume: $R/(T_c+R) = .3$

$\therefore R = .429\, T_c$ *

	L (mi)	H (ft)	T_c (Hrs)	R (Hrs)
Sub Area 1	6.534	720	8.26	3.54
" " 2	4.545	500	6.25	2.68
" " 3	4.356	560	5.70	2.44
" " 4	3.078	600	3.71	1.59
" " 5	.871	660	.83	.36
" " 6	2.367	660	2.84	1.22
" " 7	1.326	550	1.45	.62

SCS

$L = \dfrac{l^{.8}\,(S+1)^{.7}}{1900\, Y^{.5}}$ $\quad T_c = L/.6$ $\quad S = \dfrac{1000}{CN} - 10 = \dfrac{1000}{72} - 10 = 3.89$

	l (ft)	S (constant)	Y (%)	L (Hrs)	T_c (Hrs)	R (Hrs)
Sub Area 1	34500	3.89	10	2.158	3.59	1.54
" " 2	24000	3.89	10	1.614	2.69	1.15
" " 3	23000	3.89	10	1.560	2.60	1.12
" " 4	16250	3.89	10	1.180	1.97	.84
" " 5	4600	3.89	10	.430	.72	.31
" " 6	12500	3.89	10	.958	1.59	.68
" " 7	7000	3.89	10	.602	.36	.16

* North Atlantic Regional Water Resources Study - February 1972

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DESIGN BRIEF

PROJECT NAME NEW YORK STATE DAM INSPECTION DATE 5.1.79

SUBJECT MINE LAKE DAM (WEST POINT, NY) PROJECT NO. 2277

ESTIMATE OF SNYDERS PARAMETERS DRAWN BY JPG

640 Cp

		Cp
SUBAREA	1	.625
"	2	.625
	3	.625
	4	.625
	5	.625
	6	.625
	7	.625

$t_p = C_t (L \cdot L_{ca})^{.3}$

		Ct	L(mi)	Lca(mi)	tp
SUB AREA	1	2.0	5.48	1.14	3.465
" "	2	2.0	4.07	2.04	3.774
" "	3	2.0	3.12	1.56	3.215
" "	4	2.0	2.76	1.38	2.987
" "	5	2.0	.87	.43	1.489
" "	6	2.0	1.38	.69	1.971
" "	7	2.0	1.19	.59	1.799

$t_r = t_p / 5.5$

		tp	tr
SUB AREA	1	3.465	.63
" "	2	3.775	.69
" "	3	3.215	.59
" "	4	2.987	.54
" "	5	1.489	.27
" "	6	1.971	.36
" "	7	1.799	.33

$t_{pr} = t_p + .25 (t_R - t_r)$

		tp	tR	tr	tpr
SUB AREA	1	3.465	1.0	.63	3.56
" "	2	3.775	1.0	.69	3.85
" "	3	3.215	1.0	.59	3.32
" "	4	2.987	1.0	.54	3.10
" "	5	1.489	1.0	.27	1.67
" "	6	1.971	1.0	.36	2.13
" "	7	1.799	1.0	.33	1.97

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DESIGN BRIEF

PROJECT NAME NEW YORK STATE DAM INSPECTION DATE 5.1.79

SUBJECT DEPTH- DURATION RELATIONSHIP (WEST POINT, NY) PROJECT NO 2277

MINE LAKE DAM DRAWN BY JPG

HYDROMETEOROLOGICAL REPORT Nº 33

PMP INDEX RAINFALL

24 HR

200 MI² - 22.0"

TYPICAL FOR DRAINAGE SUB AREA 1 THRU 7

DURATION	%	DEPTH
6 HR	111	24.42
12 HR	123	27.06
24 HR	133	29.26
48 HR	142	31.24

```
(0001)   A1 MINE LAKE DAM
(0002)   A2 HEC1DB MODEL
(0003)   A3 FMF-DAM OVERFLOW   DAM BREAK ANALYSIS
(0004)   B      50         1         0         0         0         0         0         4
(0005)   E1     >
(0006)   J      1         0         1
(0007)   J1   0.2       0.4       0.5       0.6       0.8       1.0
(0008)   K      .         1         0         0         0         0         1
(0009)   K1   SUB AREA 1 RUNOFF INTO POPCLOPEN LAKE - CLARK METHOD
(0010)   M      1         1     5.00         0     8.73         .         0         0         1
(0011)   P      2        22       111       123       133       142
(0012)   T      0         0         0         0         0         0         1       0.1
(0013)   A   3.47    0.005
(0014)   A     -2        -.1       1.0
(0015)   K      1         1         0         0         0         0         1
(0016)   K1   ROUTE  VER POPCLOPEN LAKE DAM
(0017)   Y      .         2         0         1         1
(0018)   Y1     1         0         0         0         0         .        -1
(0019)   ES     0     149.8     299.2     448.6     598.4      74.      297.7    1047.2    1196.8    1346.4
(0020)   AS   149.      1045.0    1795.2
(0021)   SE    672       679       686       681       682       683       684       685       686       687
(0022)   SE    688       689       690
(0023)   .     .5        7.        3.0       1.0
(0024)   SD   72.7      2.04      1.0       3.0
(0025)   P      1         2         3         .         .         .         1
(0026)   K1   CHANNEL ROUTE THRU AREA 2
(0027)   Y      .         0         0         1         1
(0028)   Y1     1         0         0         0         0         .        -1
(0029)   YO     .5        .04       .05       644       66.      21.       .16
(0030)   Y7     1         66.       3.0       66.       5.        6.       31.       644       52        644
(0031)   Y2    50.        44.       7.0       22.       9.0       9.0       .
(0032)   K      .         2         0         0         0         0         .         1
(0033)   K1   SUB AREA 3 RUN OFF INTO MINE LAKE
(0034)   .      .         1     5.00         .      6.73         .         .         .         1
(0035)   .      .        22       111       123       133       142
(0036)   T      0         0         0         0         0         0         1       0.1
(0037)        3.77    .005
(0038)   A     -2        -.1       1.0
```

```
(CC34)   K       2       2
(CC40)   K       1       3       0       0       0       0       1
(CC41)   K1  ROUTE OVER MINE LAKE DAM
(CC42)   Y       0       0       0       1       1
(CC43)   Y1      1       0       0       0       0       0      -1       0
(CC44)   SS      0      40     165     210   212.5     225   237.5     215     275     350
(CC45)   SS   400     450
(CC46)   SE 634.7     641   648.7   649.2   649.7   650.2   650.7   651.2   651.7   652.7
(CC47)   SE 653.7   654.7
(CC48)   SS 646.7     145     3.2     1.5
(CC49)   SD 650.7     2.04    1.5     375
(CC50)   K       -       3       0       0       0       0       1
(CC51)   K1  SUB AREA 3 RUNOFF INTO STILLWELL LAKE
(CC52)   M       1       1   3.233       0   1.147       0       0       1
(CC53)   P       0      22     111     125     135     142
(CC54)   T       0       0       0       0       0       0       1     0.1
(CC55)   S   3.222    .0625
(CC56)   X      -2    -1.1     1.7
(CC57)   K       0       3
(CC58)   K       1       3       0       0       0       0       1
(CC59)   K1  ROUTE OVER STILLWELL LAKE DAM
(CC60)   Y       0       0       0       1       1
(CC61)   Y1      1       0       0       0       0       0      -1
(CC62)   SS          253.4   500.2   700.2  1013.6  1207.7  1362.4  1773.2  1827.2  2200.0
(CC63)   SS  2334   2774.4  3140.2  3694.2
(CC64)   SL   614     660     681     690     694     696     697     698     699     699
(CC65)   SE   624     626     629     650
(CC66)   SD   2.4     100     3.2     1.5
(CC67)   SD   175     2.04    1.5     325
(CC68)   K       1       4       0       0       0       0       1
(CC69)   K1  CROSSFIELD ROUTE THRU SUB AREA 4
(CC70)   Y       0       0       0       1       1
(CC71)   Y1      1       0       0       0       0       0      -1
(CC72)   YS      0     .04     .25     540     710    1100    .625
(CC73)   YT     15      60     150     500     620     900     500     540     610     540
(CC74)   YT     50      50     750     500     900     600
(CC75)   K       4       4       0       0       0       0       1
(CC77)   K1  SUB AREA 4 RUNOFF
```

```
(0077)  P      1      1    3.2[illegible]   0   16.47     0      0      0      1
(0078)  F      [illegible]   .2    111    125    133    142
(0079)  T      [illegible]   [illegible]   [illegible]   0      0      0      1    0.1
(0080)  W   2.99   .025
(0081)  X     -2   -0.1    1.[illegible]
(0082)  K      2      4
(0083)  K      1      5      [illegible]   0      0      [illegible]   1
(0084)  K1  CHANNEL ROUTE THRU AREA 5
(0085)  Y      [illegible]   0      0      1      1
(0086)  Y1     1      0      0      [illegible]   0      [illegible]  -1
(0087)  Y6   .[illegible]   .04    .[illegible]   530    600    415   .[illegible]
(0088)  Y7   1[illegible]   600    1[illegible]   540    220    54[illegible]   540    530   13[illegible]   530
(0089)  Y7  16[illegible]   540   17.0    5[illegible]   900    6[illegible]
(0090)  K      [illegible]   5      0      0      0      [illegible]   1
(0091)  K1  SUB AREA 5 RUNOFF
(0092)  P      1      1    .[illegible]   0   16.47     [illegible]   0      0      1
(0093)  F      [illegible]   .2    111    125    133    142
(0094)  T             0      [illegible]   0      0      [illegible]   1    0.1
(0095)  W   1.4[illegible]   .025
(0096)  X     -[illegible]  -0.1    1.
(0097)  K      [illegible]   0      [illegible]   0      0      0      1
(0098)  K1  SUB AREA 6 RUNOFF
(0099)  P      1      1    1.[illegible]        15.47     [illegible]   [illegible]   [illegible]   1
(0100)  F             .2    11[illegible]   125    133    14[illegible]
(0101)  T             0      [illegible]   0      0      0      1    0.1
(0102)  W   1.97   .025
(0103)  X     -[illegible]  -0.1    1.[illegible]
(0104)  K             5
(0105)  K      1      [illegible]          0      0             1
(0106)  K1  CHANNEL ROUTE THRU AREA 7
(0107)  Y             0             1      1
(0108)  Y1     [illegible]   0             0      0      [illegible]  -1
(0109)  Y6   .[illegible]   .04    .[illegible]   450    500    415[illegible]   .0[illegible]
(0110)  Y7   3[illegible]   480    5[illegible]   46[illegible]   65[illegible]   44     [illegible]   4[illegible]   12[illegible]   450
(0111)  Y7  14[illegible]   44[illegible]   1[illegible]   4[illegible]   1[illegible]   4
(0112)  K             7             0      0      [illegible]   1
(0113)  K1  SUB AREA 7 RUNOFF
(0114)  P      1      1    .[illegible]   [illegible]   16.47     [illegible]   [illegible]   [illegible]   1
```

```
(0115)   P          .        <<      111      1<5      155      1><
(0116)   T          C        L       C        C        L        -        1      0.1
(0117)   W      1.  L      .025
(0118)   X         -<      -0.1      1.<
(0119)   K          <        <
(0120)   K         />
(0121)   A
(0122)   A
(0123)   A
(0124)   A
(0125)   A
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	1
ROUTE HYDROGRAPH TO	2
RUNOFF HYDROGRAPH AT	2
COMBINE 2 HYDROGRAPHS AT	2
ROUTE HYDROGRAPH TO	3
RUNOFF HYDROGRAPH AT	3
COMBINE 2 HYDROGRAPHS AT	3
ROUTE HYDROGRAPH TO	3
ROUTE HYDROGRAPH TO	4
RUNOFF HYDROGRAPH AT	4
COMBINE 2 HYDROGRAPHS AT	4
ROUTE HYDROGRAPH TO	5
RUNOFF HYDROGRAPH AT	5
RUNOFF HYDROGRAPH AT	6
COMBINE 3 HYDROGRAPHS AT	5
ROUTE HYDROGRAPH TO	6
RUNOFF HYDROGRAPH AT	7
COMBINE 2 HYDROGRAPHS AT	7

END OF NETWORK

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  28 FEB 79
**********************************

RUN DATE?mED= 'M. 07 1979
     TIME?14:45:14

                    MINE LAKE DAM
                    HEC1DB MODEL
                    PMF-DAM OVERFLOW   DAM BREAK ANALYSIS

                                    JOB SPECIFICATION
                    NO      NHR     NMIN     IDAY      IHR     IMIN    METRC     ITAPE     ITRT    NSTAN
                    90        1        0        0        0        0        0         4         0
                                                JOPER      NWT    LROPT    TRACE
                                                    5        0        0        0

                                    MULTI-PLAN ANALYSES TO BE PERFORMED

                                        NPLAN= 1 NRTIO= 6 LRTIO= 1
                                  RTIOS=   0.00   0.40   0.50   0.60   0.80   1.00

          **********          **********          **********          **********          **********

                                    SUB-AREA RUNOFF COMPUTATION

                    SUB AREA 1 RUNOFF INTO A PONDED LAKE - CLARK METHOD
                                  IST A   ICOMP   IECON    ITAPE    JPLT    JPRT    INAME   ISTAGE   I AUTO
                                      1       0                0                        1        0        0

                                    HYDROGRAPH DATA
                                IPLPT    IUNG    TAREA    SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
                                    1        1     5.00    0.00     4.73     0.00    0.000                1        0

                                    PRECIP DATA
                                      SPFE      PMS       R6       R12      R24      R48      R72      R96
                                      0.00    22.00   111.00   125.00   133.00   142.00     0.00     0.00
TRSPC IS ENTERED BY THE PROGRAM IS 0.500

                                    LOSS DATA
                                LOSS    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
                                    1     0.00     0.00     1.00     0.00     0.00     1.00     1.00     0.10     0.00     0.0

                                    UNIT HYDROGRAPH DATA
                                        TP=  3.47     CP=0.65     NTA=  0
```

RECESSION DATA
STRTG= -2.00 QRCSN= -0.10 RTIOR= 1.60

UNIT HYDROGRAPH 20 END-OF-PERIOD ORDINATES, LAG= 3.47 HOURS, CP= 0.62 VOL= 1.00

83.	304.	534.	631.	546.	401.	295.	217.	159.	117.
86.	63.	46.	34.	25.	18.	13.	10.	7.	5.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.99	21.28	3.71	91365.
										(635.)(541.)(94.)(2587.17)			

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

"LIE OVER PUMPLEMEN LAKE DAM

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IPRT	IPMP	LSTR
0.0	0.000	0.00	1	1		0	0

NSTPS	NSTPL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1		0	0.00	0.000	0.000	-1.	0

CAPACITY=	0.	100.	299.	449.	599.	749.	898.	1047.	1197.	1346.
	1496.	1647.	1795.							
ELEVATION=	677.	679.	680.	681.	682.	683.	684.	685.	686.	687.
	688.	689.	690.							

CREL	SPWID	COQW	EXPW	ELEVL	CAREL	CAREA	EXPEL
77.0	2.0	3.2	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
679.9	2.6	1.5	Sec.

PEAK OUTFLOW IS 1951. AT TIME 44.00 HOURS

PEAK INFLOW IS 2710. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 1861. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 1842. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 2554. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 1861. AT TIME 44.00 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTE TPRU AREA c

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	ICLTO
c	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QU(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.03	.041	0.0410	644.0	680.0	2100.	0.0163

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

1	0.00	0	0.00	300.00	0.00	0.00	300.00	644.00	0.00	0.00	644.00
5	0.00	0	0.00	700.00	0.00	0.00	900.00	691.00			

ST RAGE	0.00	1.00	2.00	3.71	5.37	7.07	9.37	11.69	14.23
	74.43	101.00	167.15	217.78	271.41	329.27	390.25	54.66	522.54
ELEV	0.00	100.79	404.04	603.07	1307.47	1953.51	2771.00	3761.59	4819.85
	134000.09	226030.87	340011.00	491402.61	663500.00	861102.95	1086028.91	133 47.56	161890.69
STAG	644.00	645.87	647.77	649.66	651.53	653.47	655.37	657.26	659.16
	0.000	654.64	660.74	666.83	670.93	672.42	674.31	676.21	678.10
FLO	0.0	100.7	404.04	603.07	1307.49	1953.51	2771.00	3761.59	4819.85
	134000.09	226030.87	340011.00	491402.61	663500.00	861102.95	1086028.91	133 47.56	161890.69

MAXIMUM STAGE IS 652.5

MAXIMUM STAGE IS 657.0

MAXIMUM STAGE IS 658.9

MAXIMUM STAGE IS 659.3

MAXIMUM STAGE IS 661.0

MAXIMUM STAGE IS 661.7

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

SUB AREA 2 RUNOFF INTO MINE LAKE

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDO	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.15	0.00	0.79	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PXS	R6	R12	R24	R48	R72	R96
0.00	2.00	111.00	143.00	165.00	192.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIOI
1	0.00	0.00	1.00	0.00	.00	1.0	1.00	0.10	0.00	0.0

UNIT HYDROGRAPH DATA

TP= 3.77 CP=0.63 NTA= 0

PRECIPITATION DATA

STRTP= -2.00 RTIOP= 1.60

UNIT HYDROGRAPH 21 END-OF-PERIOD FLOWS, LAG= 3.75 HOURS, CP= 0.63 VOL= 1.00

41.	145.	264.	252.	3 9.	257.	177.	131.	95.	75.
54.	40.	31.	22.	17.	14.	9.	7.	5.	4.
3.									

END-OF-PERIOD FLOW

AREA	PERIOD	RAIN	EXCS	LOSS	COMP Q	PEAK	FR.AR	PERIOD	RAIN	EXCS	LOSS	COMP Q
								SUM	24.99	21.28	3.71	5061.
									(635.)	(541.)	(94.)	(1433.99)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	2	0	0	0	0	0	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE OVER VINE LAKE DAM

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

WLOSS	CLOSS	AVG	IRES	ISAME	INFT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

CAPACITY=	0.	45.	165.	200.	215.	225.	238.	215.	275.	300.
	425.	450.								
ELEVATION=	634.	641.	649.	649.	650.	650.	651.	651.	652.	653.
	654.	655.								

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
647.7	145.0	3.2	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
650.9	2.6	1.5	373.

ITERATIVE SOLUTION DID NOT CONVERGE FOR PERIOD 49 SUB-STEP 1 TIME 49.00 HR
ESTD PEAK 0.0 ELEV 6.504E 02 6.515E 02 CONTINUITY BALANCE -4.248E 02 1.479E 01

PEAK OUTFLOW IS 2552. AT TIME 49.00 HOURS
ITERATIVE SOLUTION DID NOT CONVERGE FOR PERIOD 51 SUB-STEP 1 TIME 51.00 HR
ESTIMATED W.S. ELEV 6.513E 02 6.512E 02 CONTINUITY BALANCE 2.365E 02 -4.945E 01

PEAK OUTFLOW IS 3436. AT TIME 42.00 HOURS
ITERATIVE SOLUTION DID NOT CONVERGE FOR PERIOD 52 SUB-STEP 1 TIME 52.00 HR
ESTIMATED W.S. ELEV 6.512E 02 6.511E 02 CONTINUITY BALANCE 2.365E 01 -2.756E 00

PEAK OUTFLOW IS 4169. AT TIME 44.00 HOURS
ITERATIVE SOLUTION DID NOT CONVERGE FOR PERIOD 53 SUB-STEP 1 TIME 53.00 HR
ESTIMATED W.S. ELEV 6.50?E 02 6.5?E 02 CONTINUITY BALANCE -1.?44E 02 3.35? E1

PEAK OUTFLOW IS 4?7?. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 11?26. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 1?.?5. AT TIME 45.?? HOURS

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

SUB-AREA 3 IN PT 1 TO STILLWELL LAKE

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.25	0.0	18.47	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.00	111.00	129.00	138.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.821

LOSS DATA

LROPT	STRKS	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00	0.0

UNIT HYDROGRAPH DATA

TP= 3.22 CP=0.63 NTA= 0

RECESSION DATA

STRTQ= -2.00 QRCSN= -0.10 RTIOR= 1.00

UNIT HYDROGRAPH 10 END-OF-PERIOD ORDINATES, LAG= 3.23 HOURS, CP= 0.52 VOL= 1.0

57.	262.	548.	393.	324.	228.	161.	113.	80.	56.
40.	28.	20.	14.	10.	7.	5.	3.		

[illegible] END-OF-PERIOD FLOW

[illegible]	MAX/MIN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.63	21.92	3.71	55392.
										(651.)	(557.)	(94.)	(1568.53)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	4	0	6	0	0	0	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

[illegible] COLOR HILL ELL LAKE DAM

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

[illegible]	[illegible]	[illegible]	TRSS	[illegible]	[illegible]	IRMP	[illegible]

	C.C	C.CCC	C.CC	1	1	C	C		C	

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	2	0	C.CC0	C.CC0	C.CCC	-1.	C

CAPACITY=	C.	2[illegible].	567.	766.	1014.	1267.	1520.	1774.	2027.	2281.
	2534.	2787.	3041.	3294.						
ELEVATION=	604.	606.	608.	611.	612.	614.	616.	618.	620.	622.
	624.	626.	628.	630.						

CREL	SPWID	COQW	EXPW	FLEVL	COQL	CAREA	EXPL
604.0	150.0	3.0	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COPD	EXPD	DAMWID
619.5	0.0	1.5	300.

PEAK OUTFLOW IS 526. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 7567. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 9466. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 11413. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 12931. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 2247. AT TIME 44.00 HOURS

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[illegible] ROUTING DATA

CHANNEL ROUTING [illegible]

IST	ICOMP	IECON	ITYPE	JRPT	JPPT	INAME	ISTAGE	ICTRL
4	1	0	0	0	0	1	0	0

[illegible] ROUTING DATA

[illegible]	CLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		ISTR
	C.0	0.000	C.CC	1	1	0	0		C

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	1	0	0.000	0.000	0.000	-1.	0

CROSS SECTION FOR CHANNEL ROUTING

[illegible] ELEV [illegible] SEE

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
1.00.00 [illegible] 100.00 500.00 220.00 500.00 300.00 540.00 310.00 540.00
560.00 560.00 750.00 580.00 900.00 600.00

STORAGE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42.26	59.98	80.89	105.33
	140.25	159.99	230.54	260.4	325.45	372.63	422.21	474.20	528.59
OUTFLO	[illegible]	393.63	1958.70	5409.49	11134.37	19629.96	31317.78	49 40.00	71921.52
	130694.91	165632.38	216536.63	250446.22	300208.06	354665.94	413685.81	477158.06	545729.25
STAGE	540.00	543.10	546.36	549.47	552.63	555.79	558.95	562.10	565.26
	571.5	574.74	577.89	581.05	584.21	587.37	590.53	93.68	596.84
FLO	[illegible]	393.63	1958.70	5409.49	11134.37	19629.96	31317.78	49 40.00	71921.52
	130694.91	165632.38	216536.63	250446.22	300208.06	354665.94	413685.81	477158.06	545729.25

MAXIMUM STAGE IS 547.5

MAXIMUM STAGE IS 550.0

MAXIMUM STAGE IS 551.7

MAXIMUM STAGE IS 552.7

MAXIMUM STAGE IS 554.4

MAXIMUM STAGE IS 556.1

********** ********** ********** ********** **********

[illegible]-AREA ROUTING COMPUTATION

SUB AREA NUMBER
ISTAO ICOMP INAME ITYPE JRCH JPRT INAME ISTAGE ICONT
4 2 1 0 0

YOUNGS DATA
IPRT IPLT TAREA SNAP TRSDA TRSPC RATIO ISAME ISAME LOCAT
1 1 5.00 0.00 10.47 0.10 0.000 1

HYDROGRAPH DATA
TRSDA TRSPC N RTIOR RTIOK STORA PRAIN STRKR
0.0 22.00 111.00 125.00 1.000 140.00 0.00 0.00
INSEC COMPUTED BY THE PROGRAM IS 0.021

LOSS DATA
LOSS STRKR DLTKR RTIOL CNPRV STRTL CNSTL LSTRKR RTIOR

1 0.00 0.00 1.00 0.00 0.00 1.00 1.00 0.10 0.00 0.0

UNIT HYDROGRAPH DATA
TP= 2.99 CP=0.65 NTA= 0

RECESSIO DATA
STRTQ= -2.00 QRCSN= -0.10 RTIOR= 1.60

UNIT HYDROGRAPH 15 END-OF-PERIOD ORDINATES, LAG= 2.97 HOURS, CP= 0.65 VOL= 1.0
26. 154. 415. 452. 369. 213. 140. 92. 60. 40.
23. 17. 11. 7. 5.

END-OF-PERIOD FLOW
AM.DA PR.MN PERIOD RAIN EXCS LOSS COMP Q PC.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q

SUM 25.03 21.92 3.71 56904.
(651.)(557.)(94.)(1611.34)

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COMBINE HYDROGRAPHS
IST-W IC.MF IECON ITAPE JOLT JRRT INAME ISTAGE I CTO
4 2 0 0 0 0 0 0 0

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HYDROGRAPH ROUTING

C***CEL ROUTE THRO ***EA
IST IC.MF IECON ITAPE JOLT JRRT INAME ISTAGE I CTO
5 1 1 1 0

***TION DATA
GL SS CL***S -AV. IRTIO ITAPE IRES ISAME LSTR
0.0 0.000 0.00 1 1 1 0 0

.STPS .ST.L EXP .***OR X TSK STORA ISPRAT
1 0 .** 0.00 0.00 -1. 0

***L D* T ***-EL ***TION
---

*.(1) *.(2) *.(3) ELMAT ELMAX REATIO SEC
.** .** .** 35.. 0.. 4150. . .

CR** SECTION C HEIGHT C--STA,ELEV,STA,ELEV--ETC
1 *** 0 0.0 1 0.0 56 .0 2 .0 34 .0 34.. 35 .0 13 0.0 55 .0
2 . .. . 17 .0 5 . . 0 . . 0 . .

STAGE	[illegible]	[illegible]	424.19	659.53	966.76	1146.36	1395.85	1649.21	1906.46
	2427.24	2683.55	2959.66	3227.99	3498.12	3770.19	4044.19	4320.14	4598.03
OUTFLOW	[illegible]	8311.5	26783.5%	54058.74	96542.55	134283.28	184796.81	241726.47	304796.81
	448026.5%	52788[illegible].3%	614425.38	705172.75	[illegible]0985.88	901757.88	1007393.75	1117[illegible]6.00	1232916.75
STAGE	532.0[illegible]	533.6[illegible]	537.37	541.55	544.74	548.42	552.11	555.79	559.47
	562.[illegible]4	570.5[illegible]	574.21	577.[illegible]	581.5[illegible]	585.26	588.95	592.63	596.32
FLOW	[illegible].0[illegible]	8311.5[illegible]	26783.5%	54058.74	96542.55	134283.28	184796.81	241726.47	304796.81
	448026.5[illegible]	52788[illegible].3	614425.38	705172.75	[illegible]0985.88	901757.88	1007393.75	1117[illegible]6.00	1232916.75

MAXIMUM STAGE IS 531.[illegible]

MAXIMUM STAGE IS 534.[illegible]

MAXIMUM STAGE IS 534.5

MAXIMUM STAGE IS 535.

MAXIMUM STAGE IS 537.1

MAXIMUM STAGE IS 537.[illegible]

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SUB-AREA ROUTE COMPLETATION

SUB AREA [illegible] [illegible]

ISTA	ICONE	IECO	ITYPE	JSTA	JSTA	INAME	ISTAGE	ICTRL
2	1	1	1	1	1	1	1	1

HYDROGRAPH DATA

IHYDR	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISAME	ISAME	LOCAL
1	1	0.03	0.01	15.47	0.01	0.000	1	1	0

RECEIP DATA

SPFE	RMS	PX	R1Y	R24	R48	R72	R96
0.75	0.25	131.00	1.50	135.00	140.00	0.75	0.50

INSPEC [illegible]ETER OF THE PEAK RATE IS 0.01

LOSS DATA

INITL	STRKR	CNSTL	RTIOL	CLSTP	IRES	RTIOR	STRTL	CNSTL	ALSMX	RTIOI
0	0.00	1.00	1.00	0.70	0.00	1.00	1.00	0.19	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.49 CP=1.65 NTAB= 0

RECESSION DATA

STRTG= -2.CC GRCSN= -.1. RTIOR= 1.60

UNIT HYDROGRAPH (END-OF-PERIOD ORDINATES, LAG= 1.49 HOURS, CP= 0.62 VOL= 1.CC

1..C. 2C5. 1.9. 58. 24. 1C. 4. 2.

(END-OF-PERIOD FLOW

..DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	..DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.63	21.92	3.71	16167.
										(651.)(557.)(94.)(			457.8C)

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SUB-AREA RU..FF COMPUTATION

SUB AREA C.ANNEL

ISTAG	ICOMP	IECON	ITYPE	JPLT	JPRT	INAME	ISTAGE	ICTO
C	C	C	C	C	C	1	C	C

HYDROGRAPH DATA

I.YE..	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.47	C.CC	1C.47	..	C..CC		1	

..VIOUS DATA

SEE	.MS	..	.1	...	W4.	RZ.	RM
.00	CC.CC	111..	1CC.	1 ..	1W...	C...	C..

TRSPC COMPUTED BY THE PROGRAM IS 1.CC1

LOSS DATA

LOSS	STRKR	DLTK	RTIOL	STRTL	CNSTL	ALSMX	RTIOF
..	.	1.	1..	.	1.	1.0	..1.	1.CC	. .

UNIT HYDROGRAPH DATA

TP= 1.49 CP=..62 NTA= C

RECESSION DATA

STRTQ= -2.C. QRCSN= -.1. RTIOR= 1..

UNIT HYDROGRAPH 1 ORD- RECESSION (END-OF-PERIOD ORDINATES, LAG= 1.9. HOURS, CP= 1.C. VOL= 1. C

24. 64. 2... 12. .. 4C. 21. 1.. 5. 3.

(END-OF-PERIOD FLOW

..DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	..DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.63	21.92	3.71	27.36.
										(651.)(557.)(94.)(			765.57)

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COMBINE FOR PROGRAMS

ISTAW	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	ICTO
5	5	0	0	0	0	0	0	0

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HYDROGRAPH ROUTING

ISTAW	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	ICTO
6	1	0	0			1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	ISTR	TEMP		LSTR
.00	.000	0.00	1	1		0		0

RSTAR	XSTEP	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.00	0.000	-1.	0

[illegible]

[illegible]

AXIPUP STAGE IS 455.9

AXIPUP STAGE IS 454.4

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SUB-AREA RUNOFF COMPUTATION

SUB AREA / RUNOFF

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	ICLTQ
7	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	0.96	0.00	18.47	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.00	111.00	125.00	135.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.81

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.0

UNIT HYDROGRAPH DATA

TP= 1.00 CP=0.45 NSTPS= 1

RECESSION DATA

STRTQ= -2.00 QRCSN= -0.10 RTIOR= 1.00

UNIT HYDROGRAPH - 5 END-OF-PERIOD ORDINATES, LAG= 1.00 HOURS, CP= 0.45 VOL= 1.00

1.	10.	10.	4.	2.	1.	1.	0.

5-MIN-PERIOD FLOW

RUNOFF	PERIOD	RATE	EXCS	LOSS	COMP Q	BASEA	PRCP	PERIOD	MAIN	EXCS	LOSS	COMP Q
								SUM	0.00	1.92	5.71	1677.
									(.ST.)(	5.)(	94.)(	472.3C)

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COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	ICLTQ
7	2	0	0	0	0	0	0	0

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 0.20	RATIO 2 0.40	RATIO 3 0.60	RATIO 4 0.80	RATIO 5 1.00	RATIO 6 1.20
HYDROGRAPH AT	1	5.60	1	1,265.	3951.	4912.	5855.	6859.	9824.
		(14.50)		(35.84)	(111.8)	(139.10)	(166.41)	(222.55)	(278.19)
ROUTED TO	2	5.60	1	1,251.	3710.	4681.	5642.	7554.	9461.
		(14.50)		(46.79)	(105.7)	(132.55)	(159.77)	(213.91)	(267.87)
ROUTED TO	4	5.60	1	1,249.	3715.	4694.	5663.	7625.	9587.
		(14.50)		(46.70)	(104.9)	(132.93)	(160.34)	(215.91)	(265.81)
HYDROGRAPH AT	3	3.13	1	1055.	2129.	2837.	3164.	4619.	5274.
		(8.11)		(29.87)	(59.73)	(79.67)	(89.60)	(119.46)	(149.33)
2 COMBINED	5	8.73	1	2296.	5744.	7538.	8716.	11695.	14576.
		(22.61)		(65.51)	(162.74)	(214.54)	(246.80)	(331.19)	(412.94)
ROUTED TO	6	8.73	1	2286.	5[illegible]	[illegible]	8676.	11620.	15079.
		(22.61)		(75.11)	(165.27)	(215.01)	(245.51)	(334.88)	(426.52)
HYDROGRAPH AT	7	3.05	1	1187.	2427.	3[illegible]	3716.	4949.	6191.
		(7.90)		(33.04)	(68.74)	(87.59)	(105.11)	(140.14)	(175.17)
2 COMBINED	8	11.78	1	3464.	8511.	11[illegible].	12[illegible].	16477.	21[illegible].
		(31.51)		(98.55)	(241.08)	(321.[illegible])	(346.34)	(466.96)	(587.[illegible])
ROUTED TO	9	11.78	1	3[illegible].	7[illegible].	9[illegible].	11415.	15451.	19447.
		(31.05)		(93.34)	(212.59)	(283.94)	(323.16)	(437.59)	(550.[illegible])
ROUTED TO	10	11.78	1	3[illegible].	7511.	9479.	11[illegible].	15855.	20259.
		(31.05)		(93.[illegible])	(212.[illegible])	(283.51)	(323.[illegible])	(448.99)	(573.[illegible])
HYDROGRAPH AT	11	3.00	1	1736.	2[illegible].	3[illegible].	4[illegible].	5[illegible].	6[illegible].
		(7.77)		(37.76)	(73.51)	(94.39)	(115.27)	(151.03)	(186.[illegible])
2 COMBINED	12	15.78	1	4115.	9[illegible].	1[illegible].	14[illegible].	2[illegible].	25[illegible].
		(39.[illegible])		(111.54)	(272.[illegible])	(347.04)	(419.[illegible])	(570.[illegible])	(714.17)
ROUTED TO	13	15.78	1	4[illegible].	9[illegible].	1[illegible].	14[illegible].	2[illegible].	25[illegible].
		(39.50)		(115.80)	(277.[illegible])	(345.88)	(416.[illegible])	(572.19)	(717.14)

[illegible]	5	0.85	1	485.	965.	1[illegible].	1445.	1930.	2413.
		(2.20)		(13.46)(	27.33)(	54.16)(	40.99)(	54.65)(	68.32)(
[illegible]DROGRAPH AT	6	1.47	1	743.	1486.	1856.	2230.	2973.	3716.
		(3.81)		(21.05)(	42.10)(	52.62)(	63.14)(	84.19)(	105.23)(
[illegible]	7	17.58	1	4369.	10841.	13510.	16273.	22456.	28672.
		(45.53)		(123.71)(	306.97)(	382.56)(	460.[illegible])(	635.86)(	[illegible]10.4[illegible])(
ROUTED T	8	17.58	1	4371.	10752.	13641.	16451.	22239.	28716.
		(45.53)		(123.77)(	304.46)(	386.27)(	465.94)(	629.74)(	813.10)(
[illegible]DROGRAPH AT	7	0.50	1	471.	941.	1176.	1412.	1882.	2353.
		(2.53)		(13.32)(	26.65)(	33.31)(	39.97)(	53.30)(	66.62)(
[illegible] COMBINED	4	18.48	1	4556.	11141.	14167.	17055.	23137.	29689.
		(47.[illegible])		(129.04)(	315.48)(	401.24)(	482.97)(	655.17)(	840.[illegible])(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	676.00	678.00	679.90
STORAGE	0.	0.	284.
OUTFLOW	0.	0.	654.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	680.66	0.76	39 .	1651.	7.00	45.00	0.00
0.40	681.65	1.75	546.	5710.	12.00	44.00	0.00
0.50	682.04	2.14	604.	4681.	14.00	44.00	0.00
0.60	682.39	2.49	657.	5642.	15.00	44.00	0.00
0.80	683.04	3.14	754.	7554.	20.00	44.00	0.00
1.00	683.63	3.73	842.	9460.	25.00	44.00	0.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	1044.	656.5	45.00
0.40	5715.	657.6	44.00
0.50	4681.	658.0	44.00
0.60	5643.	658.3	44.00
0.80	7555.	661.2	44.00
1.00	9467.	661.7	44.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	634.30	648.70	650.90
STORAGE	0.	185.	229.
OUTFLOW	0.	0.	1493.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	651.49	0.59	250.	2502.	7.00	45.00	0.00
0.40	652.04	1.74	296.	5236.	10.00	43.00	0.00
0.50	653.03	2.73	341.	7169.	12.00	44.00	0.00
0.60	653.43	3.13	391.	8674.	12.50	44.00	0.00
0.80	654.20	3.90	434.	11824.	15.00	44.00	0.00
1.00	654.90	4.60	456.	15073.	16.00	43.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	614.00	634.00	619.80
STORAGE	0.	0.	2002.
OUTFLOW	0.	0.	32155.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	617.40	0.00	438.	3296.	0.00	45.00	0.00
0.40	619.59	0.00	759.	7507.	0.00	44.00	0.00
0.50	620.59	0.00	936.	9462.	0.00	45.00	0.00
0.60	621.52	0.00	1084.	11413.	0.00	44.00	0.00
0.80	623.26	0.00	1249.	15151.	0.00	44.00	0.00
1.00	625.01	0.00	1471.	22247.	0.00	44.00	0.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	3678.	547.5	45.00
0.40	7511.	551.2	44.00
0.50	9435.	552.7	45.00
0.60	11413.	554.2	45.00
0.80	15285.	554.4	44.00
1.00	22247.	554.8	44.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	4119.	551.6	45.00
0.40	9414.	554.0	44.00
0.50	12015.	554.5	44.00
0.60	14719.	555.1	44.00
0.80	20[illegible]8.	554.1	44.00
1.00	29[illegible]2.	553.2	44.00

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	4371.	430.0	45.00
0.40	10752.	432.0	44.00
0.50	13641.	432.5	44.00
0.60	16451.	433.1	44.00
0.80	22259.	433.9	44.00
1.00	29716.	434.4	44.00

.....

APPENDIX D

STABILITY ANALYSIS

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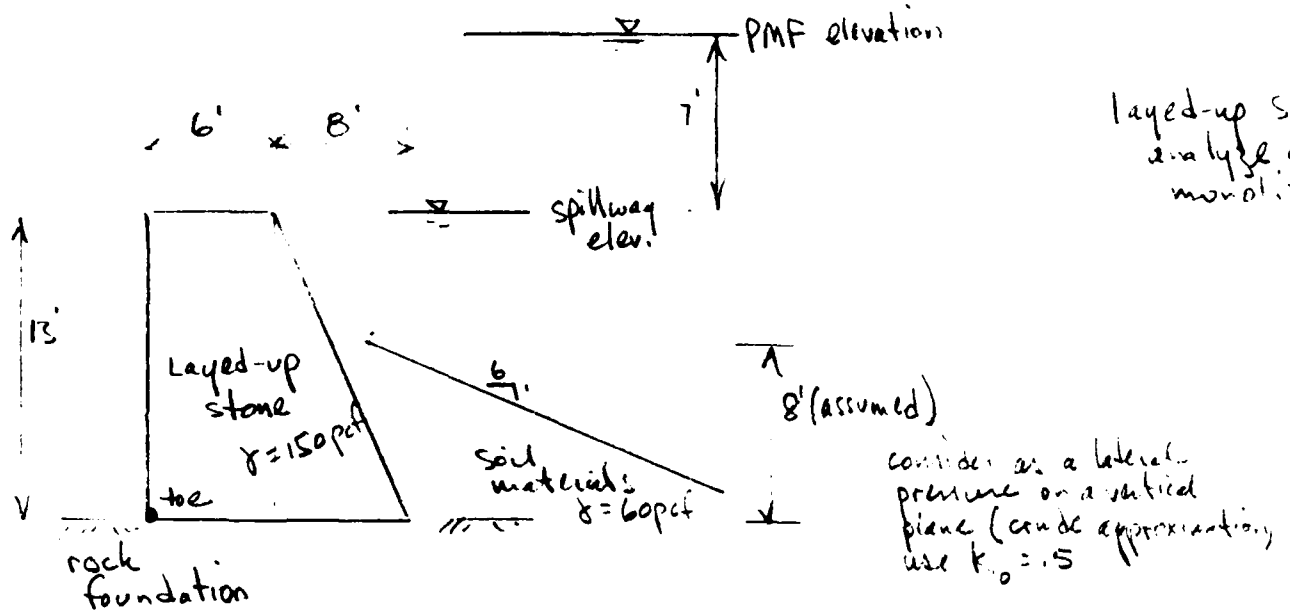
DESIGN BRIEF

PROJECT NAME MINE LAKE DAM DATE 6/30/79

SUBJECT STABILITY ANAYSIS — OVERTURNING & SLIDING PROJECT NO

DRAWN BY

assumed cross-section, spillway area



I. Overturning

(a) WL @ PMF elevation, uplift on 100% of base (analyze for condition of no thru-dam leakage, pressure behind dam full hydrostatic

(i) moments about toe, resisting (mass of dam) + vert. water pressure

$= (6\times13\times.15)\left(\frac{6}{2}\right) + \left(\frac{1}{2}\times8\times13\times.15\right)\left(6+\frac{8}{3}\right) = 35.1 + 67.6 = 102.7^{1k}$ (wt dam)

$+ \left(8\times1\frac{1}{2}\times\frac{1}{2}\times.063\right)\left(6+\frac{8}{3}\right) = 28.4$

+ 28.4

total = 131

not: neglect vertical water pressure above top of dam.

(ii) moments causing ovt: horiz. water press + uplift + lateral soil press.

62.4 × 7' = .44 KSF

70 × 67.4 = 1.25 KSF

Horiz. water press.

Uplift press

$= \left(.44^{KSF}\times13\times\frac{13}{2}\right) + (1.25-.44)\left(\frac{13}{2}\right)\left(\frac{13}{3}\right) + \left(1.25\times\frac{14}{2}\times\frac{7}{3}\times114\right) +$

$+ \left(.060\times8\times\frac{8}{2}\times\frac{8}{3}\right) =$

$= 37.2 + 23.8 + 81.7 + 3.1 = 146.8^{1k}$

Ref

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PROJECT NAME _____ DATE _____

SUBJECT _____ PROJECT NO _____

_____ DRAWN BY _____

FS against overturning =

$= \frac{131.1}{146.8}{}^{1K} = 0.90 \pm$ (uplift acting) - low -

$= \frac{131.1}{65.1} = 2.0 \pm$ (no uplift) (ok)

(b) WL @ spillway elevation, uplift on 100% of base, ice acting

(i) moment resisting = 131.1^{1K}

(ii) moment causing out: water pressure + uplift + ice + soil

$= \left(62.4 \times 13 \times \frac{13}{2} \times \frac{13}{3}\right) + \left(62.4 \times 13 \times \frac{14}{2} \times \frac{2}{3} \times 4\right) + \left(500^{\#} \times 13'\right) + 5.1^{1K}$

$= 22.9^{1K} + 53^{1K} + 65^{1K} + 5.1^{1K} = 146^{1K}$

FS against overturning =

$= \frac{131.1}{146} = 0.90 \pm$ (uplift acting ice and) - low -

$= \frac{131.1}{93} = 1.4 \pm$ (ice but no uplift) - ok -

$= \frac{131}{81} = 1.6 \pm$ (uplift, no ice) - ok -

D-2

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SUBJECT _____ PROJECT NO _____

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(c) Considering possible seismic affects for Zone 3
use horiz. coef = 0.10
vertical coef = 0.10

WL @ spillway elevation, extra out moment due to seismic water affect

$M_{ew}{}_{toe} = (0.30)\, P_{ew}\, y^2$ where $P_{ew} = (62.4 \times 13)(0.10)(.40)$ $y = 13'$

$= (0.30)(62.4 \times 13 \times 0.10 \times .40)(13 \times 13)$

$= 1.65^{1k}$

extra moment about toe due to motion of dam mass (neglect soil)

wt. dam $= \left(\frac{6+14}{2}\right)(13)(.150) = 19.5^{k}$

$M_{toe} = (0.10)\left[(11.7^{1k} \times \frac{13}{2}) + (7.8 \times \frac{13}{3}) + (11.7 \times \frac{6}{2}) + (7.8)(\frac{8}{3}+6)\right] =$

$= (0.10)[76 + 34 + 35 + 67] = 21.3^{1k}$

FS against overturning =

$= \frac{131.1^{1k}}{146 + 23^{1k}} = 0.78 \pm$ (seismic, uplift, ice acting)

$= \frac{131.1}{93+23} = 1.13 \pm$ (seismic, ice acting, no uplift)

$= \frac{131.1}{81+23} = 1.26 \pm$ (seismic, uplift act, no ice)

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DESIGN BRIEF

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_____ DRAWN BY _____

II. Sliding

(a) WL @ PMF elevation, uplift on 100% of base

(i) wt. of dam = $\left(\frac{6+14}{2}\right)(13)(.150) = 19.5^{K}$

(ii) water pressure behind dam =

$\left(\frac{.144 + 1.25}{2}^{KSF}\right)(13') = 11^{K}$

(iii) uplift on base of dam =

$= \left(1.25^{KSF} \times \frac{14}{2}\right) = 8.75^{K}$

FS against sliding (friction - shear method, assuming 20 psi shear between mortar - dam stone - rock fdtn; $\mu = 0.65$)

$= \frac{\mu N + \text{bond/shear}}{\text{horiz. water pressure}} = \frac{(19.5 - 8.75)(0.65) + (.020 \times 144 \times 14)}{11} = 4.3 \pm$ - ok -

FS against sliding (friction only, no bond between dam - fdtn)

$= \frac{\mu N}{\text{horiz. water press.}} = \frac{7}{11} = 0.64 \pm$ (uplift acts) - low -

$= \frac{\mu N}{\text{horiz. water press.}} = \frac{19.5(.65)}{11} = 1.15 \pm$ (no uplift) - ok -

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SUBJECT _____ PROJECT NO _____

_____ DRAWN BY _____

(b) WL @ spillway elevation, uplift on 100% of base, ice acts

(i) wt. of dam = 19.5^k

(ii) water pressure behind dam = $\left(62.4 \times 13 \times \frac{13}{2}\right) = 5.27^k$

(iii) uplift on base = $\left(62.4 \times 13 \times \frac{14}{2}\right) = 5.68^k$

(iv) ice = 5^k

FS against sliding (friction-shear method, use 20psi bond)

$$= \frac{\mu N + \text{bond/shear}}{\text{horiz. water press.}} = \frac{(.65)(19.5 - 5.68) + (.02 \times 144 \times 14)}{5.27} = 9+ \text{ ok}$$

FS against sliding (friction only, no bond)

$$= \frac{\mu N}{\text{horiz. water press}} = \frac{8.98}{5.27} = 1.7 \pm \quad \begin{pmatrix}\text{uplift acts,}\\ \text{no ice}\end{pmatrix} \text{ - ok -}$$

$$= \frac{\mu N}{\text{horiz. water press + ice}} = \frac{8.98}{5.27+5} = 0.87 \pm \quad \begin{pmatrix}\text{uplift, ice}\\ \text{act}\end{pmatrix} \text{ - low -}$$

$$= \frac{\mu N}{\text{horiz. water press + ice}} = \frac{19.5 \times 0.65}{10.27} = 1.23 \pm \quad \begin{pmatrix}\text{ice acts,}\\ \text{no uplift}\end{pmatrix} \text{ - ok -}$$

APPENDIX E

REFERENCES

AD-A086 357 NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/1
NATIONAL DAM SAFETY PROGRAM. MINE LAKE DAM (INVENTORY NUMBER NY--FTC(U))
FEB 80 J B STETSON DACW51-79-C-0001

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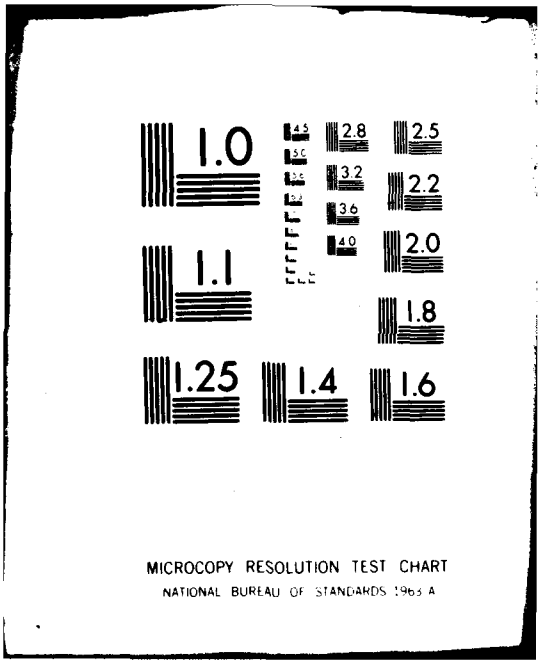
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1.4
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2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

APPENDIX

REFERENCES

1. Department of the Army, Office of the Chief of Engineers. National Program of Investigation of Dams; Appendix D: Recommended Guidelines for Safety Inspection of Dams, 1976

2. U.S. Nuclear Regulatory Commission: Design Basis Floods for Nuclear Power Plants, Regulating Guide 1.59, Revision 2, August 1977

3. Linsley and Franzini: Water Resources Engineering, Second Edition, McGraw-Hill (1972)

4. W. Viessman, Jr., J. Knapp, G. Lewis, 1977, 2nd Edition, Introduction to Hydrology

5. Ven Te Chow: Handbook of Applied Hydrology, McGraw-Hill, 1964

6. The Hydrologic Engineering Center: Computer Program 723-X6-L2010, HEC-1 Flood Hydrograph Package, User's Manual, Corps of Engineers, U.S. Army, 609 Second Street, Davis, California 95616, January 1973

7. The Hydrologic Engineering Center, Computer Program: Flood Hydrograph Package (HEC-1) Users Manual For Dam Safety

8. Soil Conservation Service (Engineering Division): Urban Hydrology for Small Watersheds, Technical Release No. 55, U.S. Department of Agriculture, January 1975

9. H.W. King, E.F. Brater: Handbook of Hydraulics, McGraw-Hill, 5th Edition, 1963

10. Ven Te Chow: Open Channel Hydraulics, McGraw-Hill, 1959

11. Bureau of Reclamation, United States Department of the Interior, Design of Small Dams: A Water Resources Technical Publication, Third Printing, 1965

12. J.T. Riedel, J.F. Appleby and R.W. Schloemer: Hydrometeorological Report No. 33, U.S. Department of Commerce, U.S. Department of Army, Corps of Engineers, Washington, D.C., April 1956. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

13. North Atlantic Regional Water Resources Study Coordinating Committee: Appendix C, Climate, Meteorology and Hydrology, February 1972

14. Water Resources Engineers, Inc., Lower Hudson River Basin, Hydrologic Flood Routing Model, January 1977

15. "Permeability Pore Pressure, and Uplift in Gravity Dams", by Roy W. Carlson, Transactions ASCE, Volume 122, 1957

16. The University of the State of New York - The State Education Department - State Museum and Science Service - Geological Survey: Geological Map of New York (1961)

17. Y.W. Isachsen and W.G. McKendree, 1977, Preliminary Brittle Structures Map of New York, Lower Hudson Sheet, New York State Museum Map and Chart Series No. 31C

18. R.T. Dodd, Jr., 1965, Precambrian Geology of the Popolopen Lake Quadrangle, Southeastern New York: New York State Museum and Science Service, Map and Chart Series No. 6

19. Y.P. Aggarwal and L.R. Sykes, 1978, Earthquake Faults, and Nuclear Power Plants in Southern New York and Northern New Jersey: Science, Volume 200, Page 425-426


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